

NORTHEAST FLOOD STUDIES
REPORT
ON
REVIEW OF SURVEY
FOR
FLOOD CONTROL AND ALLIED PURPOSES
ANDROSCOGGIN RIVER BASIN
MAINE AND NEW HAMPSHIRE
IN THREE VOLUMES
VOLUME II



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

22 JUNE 1967

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APPENDIX A

DIGEST OF PUBLIC HEARINGS

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DIGEST OF PUBLIC HEARINGS

Public hearings were held in Berlin, New Hampshire and Lewiston, Maine on 13 and 14 December 1960, respectively, to ascertain the needs and desires of local interests for flood control and allied purposes in the Androscoggin River basin. Approximately 50 people attended each hearing, including representatives of Federal, State, city, and town governments, industrial establishments, civic organizations, and interested individuals. A digest of the public hearings and letters relevant thereto is included in this Appendix. Brigadier General Seymour A. Potter, Jr., Division Engineer, was Hearing Officer at each hearing.

DIGEST OF PUBLIC HEARING - 13 DECEMBER 1964

BERLIN, NEW HAMPSHIRE

Speaker	Interest Represented	Improvement Desired, Reasons Advanced, or other Remarks
Mr. Lavier Lamantagne, Mayor	City of Berlin, N.H.	Briefly described the damage to property in the city from floodwaters on the Dead River.
Mr. Arthur J. Bergeron, Attorney	Board of Selectmen Town of Gorham, N.H.	Read Brief from Town of Gorham, N.H. Suggested a flood control dam on Peabody River, and diversion of floodwaters on Moose River to Moose Brook and into a new channel to the Androscoggin River. Submitted summary of flood induced expenses to State and Town for past decade.
Mr. John S. Busby, Asst. Division Engineer	Canadian National Railways (Grand Trunk)	The railroad experiences damage from floodwaters on the Peabody, Moose, and Androscoggin Rivers. All costs and repair of tracks and road-bed are made by the railroad. Dredging the channel of the Androscoggin River, adjacent to the Grand Trunk line, would lessen the flood problem in that area.
Mr. Edward C. VonWild, Shelburne, N.H.	Interested Individual	Reported that debris from city dumps and sawmills, and pulp plug the intake bays of the Shelburne powerhouse. Believed a river patrol should be established to prevent the disposal of debris in the river. If debris is removed from dam so that new gates can be installed and future flushing is possible, odors that occur during warm days in the summer would be eliminated. About 300 feet of the Grand Trunk Railroad tracks in Shelburne are often flooded. Also submitted paper containing suggestions for improvements of the Androscoggin River channel between Berlin, N.H. and the N.H.-Maine boundary line.

<u>Speaker</u>	<u>Interest Represented</u>	<u>Improvement Desired, Reasons Advanced, or other Remarks</u>
Mr. Tony G. Eastman, Berlin, N.H.	Interested Individual	Requests restoration of the deteriorating Pontook Dam. The dam, constructed of wood and located about 15 miles upstream of Berlin, created an excellent fishing and wildlife area.
Mr. Allen I. Lewis, Engineer	N.H. Dept. of Fish and Game	The Department welcomed the opportunity to work with the Corps of Engineers to assure that conservation elements will be considered in the projects as in the past.

LETTERS AND STATEMENTS RECEIVED AT HEARING

BERLIN, NEW HAMPSHIRE

<u>Writer</u>		
Mr. Douglas Horton	Selectman, Town of Randolph, N.H.	Letter, dated 13 December 1960, suggested a flood control dam with water storage for recreational facilities on the Moose River within the geographical boundaries of the town.
Mr. Gerald S. Wheeler, Forest Supervisor	U.S. Dept. of Agriculture, Forest Service, White Mountain National Forest	Statement, undated, indicated a desire to appraise impact of improvements for flood control and allied purposes on the multiple-use program for managing and protecting the resources of the National Forests. In doing this, other agencies will be consulted to determine their desires for the development. Findings will be submitted to the Corps of Engineers for consideration.

Writer	Interest Represented	Improvement Desired, Reasons Advanced, or other Remarks
Mr. Frederick M. Auer, Engineer	N.H. Dept. of Public Works and Highways	Statement, dated 13 December 1960, and made Exhibit E, described flood and high water damage to highway facilities in N.H. portion of the Androscoggin River basin since flood of 1927.

DIGEST OF PUBLIC HEARING - 14 DECEMBER 1960

LEWISTON, MAINE

Speaker

C-7 Mr. Roscoe L. Clifford, Planner	City of Auburn, Maine	Submitted official document "City of Auburn Zoning Ordinance" effective September 14, 1960. Requested it be reviewed for accuracy and for comments.
Mr. Emile Jacques, Mayor	City of Lewiston, Maine	Read statement, undated, calling for action, based on past experience and studies, to rid the Androscoggin River of pollution and make it fit for many uses for both industry and the public welfare. Present operations ordered by the courts have not increased the water quality and there is a lack of suitable water for industry. Have had proportionately too many studies and not enough action. River should be made useful for business, industry, and recreational purposes. Later in the hearing, the Mayor noted that roads in Auburn and Lewiston were inundated by floodwater about every 2 or 3 years.

Speaker	Interest Represented	Improvement Desired, Reasons Advanced, or Other Remarks
Hon. Peter A. Garland, Congressman-Elect	First Congressional District, Maine	Present as an observer.
Mr. Edward H. Brooks, Sr., Auburn, Me.	Interested Individual	Hopes the rivers in Maine will be cleared of pollution. Sometime floods will do this. Describes his process of eliminating the pollution condition.
Mr. John W. Jordon Vice-President and General Counsel	Brown Company Berlin, N.H.	In rebuttal to Mayor Jacques' statement, this speaker asked that the records of the hearing show a great deal has been accomplished by industries to reduce the pollution in the Androscoggin River. The Brown Company has spent almost \$6 million directly on the problem. Soon, raw sewage will constitute the major portion of the pollution.
4-11 Dr. Walter O. Lawrence	Administrator of Industrial Pollution of the Androscoggin River	Corporations can no longer be blamed for not developing pollution protection. The companies on the river will have spent \$20 million by next summer in reducing pollution. By then, the industrial pollution load will be lower than that of domestic sewage and the total load will be minute, as compared with the amount in 1940. (Ed. Note: At this point General Potter re-emphasized the position of the Corps of Engineers on the question of pollution, and the limits of our authority.)
Mr. P. Murphy, Lewiston, Me.	Interested Individual	Will the problem of pollution, by solids, affect the flood control measures taken by the Corps of Engineers. (Ed. Note: Dr. Lawrence stated that he believed the quantity of suspended solids present would not affect flood control works.)

Speaker	Interest Represented	Improvement Desired, Reasons Advanced, or other Remarks
Mr. Ford W. Harris Engineer, Auburn, Me.	Interested Individual	His employer, a railroad company serving a large portion of the Androscoggin River basin, is neither for nor against flood control measures, is interested in plans involving railroad facilities.
Mrs. Robert D. MacPherson	League of Women Voters of Maine	Read undated statement. The organization supports promotion of long range planning for conservation and development of water resources and stresses need for coordinated administration, regional and river basin planning, and equitable financing. While flood control should be considered in multiple-purpose projects, the main problem of the Androscoggin River is pollution caused by industrial wastes and municipal sewage. Maine's record of sewage treatment was the lowest in the nation in 1957 when about 90 percent of the sewered population disposed of raw sewage in the waterways. Maine waterways, now used principally as carriers of waste, should serve for industrial processing, domestic water supply, irrigation, and recreation, and should be free of hazards of disease and odors. There will be more demand for clean water in the next few years. Asked that Corps of Engineers develop plans to maximize use of resources in the basin to provide power, flood control, increased water supply, irrigation, recreation uses, and stream regulation. Suggested that flood plain zoning be investigated as an alternative to flood control facilities. Asked that citizens be given an opportunity to discuss and consider alternative possibilities for the development of the river, and that all agencies whose policies affect the river be coordinated to eliminate duplication.

Speaker	Interest Represented	Improvement Desired, Reasons Advanced, or other Remarks
Mr. Edward C. VonWild, Shelburne, N.H.	Interested Individual	Desires the establishment of a river patrol to prevent the disposal of debris in the Androscoggin River. Wished the engineers would clear the river of garbage. Keeping refuse out of the river will abet passage of water.

LETTERS AND STATEMENTS RECEIVED AT HEARING

LEWISTON, MAINE

Writer

9-A Mr. Vance A. Lincoln and members of the Androscoggin Lake Committee	Office of Selectmen, Town of Wayne, Maine	Letter, dated 3 December 1960, briefly describes the economic losses to the town from high water on Androscoggin Lake - a summer residential area. Nearly every spring the grossly polluted high waters on the Androscoggin River flow up the Dead River and into the lake, raising the water surface 12 to 15 feet. During the flood of March 1936 the surface rose about 27 feet. Believe a new and higher dam with larger gates on the Dead River would solve the flood problem of the lake.
Mr. E. Boyd Livesay Superintendent	Brunswick and Topsham Water District, Maine	Letter, dated 13 December 1960, reports well field frequently flooded and pumping station inundated in 1936 and 1953. Denotes damages from these floods. Since the Androscoggin River is highly polluted, the hazard of epidemics exists when flooding occurs. Present water supply not adequate to attract new water using industries. Request consideration be given to the control of floodwaters and pollution in the river.

Writer	Interest Represented	Improvement Desired, Reasons Advanced, or other Remarks
Board of Selectmen and Town Manager	Rumford, Maine	<p>Submitted statement and Code Zoning Law. Flooding of public and private properties by the Androscoggin and Swift Rivers has been of great concern to the inhabitants of Rumford and Mexico, Maine for many years. The largest flood occurred in 1936 and the next largest in 1953. Believe the most feasible method of controlling floodwaters is by retarding structures on the tributaries below Errol, N.H. and on the Swift River. Also diversion of floodwaters below Rumford would be of great benefit to the town. Despite the flood improvements made by Rumford, flooding of properties still occur.</p> <p>(Ed. Note: Supplemental letter dated 23 December 1960, requested consideration be given to: removing several river channel obstructions and dredging a part of Wheeler Island, all located on the Androscoggin River in Rumford; and dredging and straightening the channel of the Swift River. These obstructions caused ice jams that increased the height of flood flows.)</p>

APPENDIX B
HYDROLOGY AND HYDRAULICS

APPENDIX B
HYDROLOGY AND HYDRAULICS

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APPENDIX B

HYDROLOGY AND HYDRAULICS

1. INTRODUCTION

This appendix presents climatological and hydrological data for the Androscoggin River basin, the analysis of floods of record, the development of synthetic floods, the analysis of various flood control measures, and the determination of flood reductions afforded by various studied flood control projects.

GENERAL DESCRIPTION

2. ANDROSCOGGIN RIVER BASIN

The Androscoggin River basin is located principally in the southwestern part of Maine with part of the headwater area lying in the northeastern part of New Hampshire as shown on Plate No. B-1. Of the total drainage area of 3,450 square miles, approximately four-fifths (2,730 square miles) are in Maine and one-fifth (720 square miles) in New Hampshire. The lake and pond areas comprise about 143 square miles or 4.1 percent of the total area. The basin has a length of about 110 miles and a width of about 65 miles. The average elevation of the terrain is between 600 and 1,500 feet above mean sea level. The upper portions are rough, mountainous and almost entirely covered by forests. The lower portions are hilly, partly wooded and contain considerable cultivated land.

Hydrologically, the basin can be divided into three areas:

- a. The area above Errol, New Hampshire.
- b. The area between Errol and Webb River, below Rumford, Maine.
- c. The area between Webb River and the Mouth.

The upper portion of the basin above Errol, New Hampshire (D.A. = 1045 sq. mi.) includes six lakes with 661,000 acre-feet of combined usable storage capacity. Collectively these lakes are frequently called the Rangeley Lakes. Pertinent data for the Rangeley Lakes is given in Table B-1. The lake storages, used for log driving, power and recreation, also have large modifying effects on all types of floods. Because of the control exerted by the lake storage, flood flows from this portion of the basin usually do not contribute greatly to downstream flood peaks,

TABLE B-1

RANGELEY LAKES - USABLE STORAGE

	D.A.		USABLE STORAGE		
	Net	Gross	Ac-Ft.	Inches	
				Net	Gross
KENNEBAGO	101	101	16,600	3.1	3.1
RANGELEY	99	99	30,700	5.8	5.8
MOOSELOOKMEGUNTIC	182	382	192,100	19.8	9.4
RICHARDSON LAKES	90	472	<u>130,700</u>	27.2	5.2
Sub-Total		472	370, 100		14.7
AZISCOHOS	214	214	220,200	19.3	19.3
UMBAGOG	359	1045	<u>70,700</u>	3.7	1.3
Total		1045	661,000		11.9

The middle portion of the basin between Errol and Webb River drains about 1300 sq. mi. and is characterized by the Presidential and Mahoosuc Ranges of the White Mountains. Most of the tributaries are short with steep slopes and tend to generate the flood peak on the main stem of the river.

The lower portion of the basin which drains about 1105 square miles has relatively long tributaries with flat slopes and several small lakes and ponds. These physical features tend to modify and retard tributary floods. Because of their long travel time, these tributary peaks tend to synchronize with the main river peak that moves down from the central portion of the basin.

3. ANDROSCOGGIN RIVER

a. General. The main Androscoggin River originates at Errol Dam at the outlet of Umbagog Lake, New Hampshire, but the actual headwaters of the principal contributing streams lie about 50 miles further north. From Errol Dam, the river flows south turning sharply to the east near Gorham, New Hampshire. A short distance upstream

from Livermore Falls, Maine the river turns sharply again to flow south to its outlet in Merrymeeting Bay, eight miles below the head of tide-water at Brunswick, Maine. Between Errol Dam and tidewater at Brunswick, the river descends a total of 1,245 feet in 161 miles, an average slope of about 7.7 feet per mile. Included in this total fall are two steep drops, one of about 240 feet in 2.5 miles at Berlin, New Hampshire, and a second of about 180 feet in 1.6 miles at Rumford, Maine.

A tabulation of pertinent data for the Androscoggin River and its tributaries is shown in Table B-2.

TABLE B-2

ANDROSCOGGIN RIVER AND TRIBUTARIES

<u>River or Tributary</u>	<u>Drainage Area</u> (square miles)
Magalloway River at Umbagog Lake	439
Rapid River at Umbagog Lake	520
Androscoggin River at Errol, N.H., USGS Gage	1045
Androscoggin River near Gorham, N.H., USGS Gage	1363
Peabody and Moose Rivers at mouth	71
Wild River at mouth	69
Sunday River at mouth	51
Bear River at mouth	43
Ellis River at mouth	163
Androscoggin River at Rumford, Me., USGS Gage	2067
Swift River at mouth	125
Webb River at mouth	132
Nezinscot River at mouth	181
Little Androscoggin River at mouth	353
Androscoggin River near Auburn, Me., USGS Gage	3257
Androscoggin River at head of tidewater	3450

b. Magalloway River. The Magalloway River flows through Aziscohos Lake and then follows a meandering course in a southerly direction for about 47 miles to its mouth at Umbagog Lake, about three miles above Errol Dam. It drains an area of 439 square miles and has a fall of approximately 500 feet. The principal tributary of the Magalloway River is the Dead Diamond River. From the confluence of its steep headwater sources this tributary flows in a general southeasterly direction for about 17 miles.

c. Rapid River. Rapid River commences at the outlet of the Richardson Lakes at Middle Dam and flows on a general northwesterly course for about seven miles to Umbagog Lake where it joins the Magalloway River to form the Androscoggin River. It drains an area of about 520 square miles which includes the Kennebago, Rangeley, Mooselookmeguntic and Richardson Lakes.

d. Moose River. The Moose River has its source in the town of Bowman, New Hampshire and flows in a general northeast direction to its confluence with the Androscoggin River in the town of Gorham, New Hampshire. It has a drainage area of about 24 square miles and extends from the peaks of the Presidential Range for about 12 miles to its mouth with a total fall of about 5,000 feet. The topography of the basin is mountainous with steep slopes and very little effective channel storage.

e. Peabody River. The Peabody River rises in the northwest portion of the town of Pinkham Notch, New Hampshire and flows in a general northwesterly direction to its confluence with the Androscoggin River in the southeast corner of the town of Gorham, New Hampshire. It drains an area of about 47 square miles and extends from the summit of Mt. Washington for about 12 miles to its mouth and has a total fall of about 5,500 feet. The topography of this basin is similar to that of Moose River basin.

f. Wild River. The Wild River has its source at North Ketchum Pond in Beans Purchase, New Hampshire. The river follows a generally northeasterly course entering the Androscoggin River in the northwest corner of Gilead, Maine. Its drainage area of 69 square miles extends from the summit of Mt. Washington for about 15 miles and has a total fall of about 5,500 feet. The topography at this basin also is similar to the Moose River basin.

g. Sunday River. The Sunday River has its source in the vicinity of Goose Eye Mountain in Riley, Maine and flows in a general southeasterly direction for about 14 miles to its confluence with the Androscoggin River in the town of North Bethel, Maine. It drains an area of approximately 51 square miles and has a fall of about 2,400 feet.

h. Bear River. The Bear River has its source just south of the town of Grafton Notch, Maine and flows in a southeasterly course for about 13 miles to enter the Androscoggin River at Newry, Maine. Its drainage area is about 43 square miles and its fall is about 860 feet.

i. Ellis River. The Ellis River rises in Ellis Pond in the town of Roxbury, Maine and flows generally south about 20 miles to its confluence with the Androscoggin River near Hanover, Maine. The topography of the basin above Andover is mountainous with steep slopes and very little effective channel storage. Below this point, there is a broad flat plain which extends about seven miles to below North Rumford. The Ellis River has a drainage area of 163 square miles and a fall of about 200 feet.

j. Swift River. The Swift River rises in Swift River Pond about six miles northeast of the town of Houghton, Maine and flows southerly about 25 miles to its confluence with the Androscoggin River at Mexico and Rumford. It drains an area of 125 square miles and has a fall of approximately 1800 feet.

k. Webb River. The Webb River rises in Lake Webb in the town of Weld, Maine at an elevation of 678 feet above mean sea level. The river follows a meandering course in a southerly direction for about 15 miles to its mouth at the Androscoggin River at Dixfield, Maine. Its drainage area is 132 square miles and its fall about 285 feet.

l. Nezinscot River. The East and West Branches of the Nezinscot River rise in the southern slopes of a hilly region in the southern part of Peru and the northwest corner of Woodstock, Maine. The two branches flow in a general southeasterly direction about 16 miles, uniting at a point one mile below the village center of Buckfield to form the Nezinscot River. Below Buckfield, the Nezinscot River follows an easterly course for 14 miles to its mouth at the Androscoggin River at Keens Mills, about 4.5 miles northeast of Turner, Maine. It has a drainage area of 181 square miles and a total fall of about 590 feet.

m. Little Androscoggin River. The Little Androscoggin River rises in Bryant Pond in Woodstock, Maine at an elevation of about 700 feet above mean sea level. The river flows south for a short distance and then east for the remainder of its 46 mile length where it joins the Androscoggin River at Auburn, Maine. It drains an area of 353 square miles and has a total fall of about 580 feet.

4. CLIMATOLOGY

a. General. The average climate of the Androscoggin River basin is characterized by relatively cool summers and long, cold, snowy winters especially at inland points. Prevailing westerlies and cyclonic disturbances that cross the continent from the west or southwest bring to the basin frequent but short periods of heavy precipitation. The basin is also exposed to occasional coastal storms, some of the tropical origin that travel up the Atlantic seaboard. These latter storms are heavily laden with moisture from the ocean but much of their original violence is lost before reaching Maine. Precipitation, temperature and snowfall data at Rumford, Lewiston, Berlin and Errol are tabulated in Tables B-3, B-4 and B-5 and shown graphically on Plate No. B-5.

b. Temperature. The average annual temperature of the Androscoggin River basin is about 43° F, ranging from 45° F at points near the coast to about 42° F in the headwaters. The yearly range of mean monthly temperature is wide, with temperatures between 64° F and 70° F in July and August, and between 15° and 20° F in January and February. Temperature extremes range from occasional highs slightly in excess of 100° F to infrequent lows below minus 30° F.

c. Precipitation. The average annual precipitation of the Androscoggin River basin is about 40 inches distributed rather uniformly throughout the year. At any one station the range between maximum and minimum values of average monthly rainfall is only about one to two inches. Much of the winter precipitation comes in the form of snow.

d. Snowfall. The annual snowfall over the watershed varies from about 80 inches near the coast to about 170 inches in the headwaters. The water content of the snow cover in the early spring often amounts to six to eight inches over the entire basin, with 10 inches or more being quite common in the higher elevations of the White Mountains.

TABLE B-3

MONTHLY TEMPERATURES
(Degrees, Fahrenheit)

Lewiston, Maine
Elevation 182 Ft. MSL
78 Years of Record

<u>Month</u>	<u>Mean</u>	<u>Max.</u>	<u>Min.</u>
January	19.1	64	-28
February	20.2	59	-28
March	30.3	82	-18
April	42.2	87	10
May	54.1	101	27
June	63.7	99	34
July	69.6	102	44
August	67.5	98	38
September	59.9	97	28
October	49.2	90	18
November	36.7	74	2
December	24.1	63	-27
Annual	44.7	102	-28

Rumford, Maine
Elevation 674 Ft. MSL
62 Years of Record

<u>Month</u>	<u>Mean</u>	<u>Max.</u>	<u>Min.</u>
January	17.6	64	-33
February	19.0	55	-34
March	29.2	79	-18
April	41.3	86	11
May	53.4	97	25
June	61.7	98	33
July	68.2	101	40
August	65.7	98	38
September	58.1	95	26
October	47.4	85	15
November	34.9	75	-5
December	22.3	60	-27
Annual	43.2	101	-34

Berlin, New Hampshire
Elevation 1110 Ft. MSL
52 Years of Record

<u>Month</u>	<u>Mean</u>	<u>Max.</u>	<u>Min.</u>
January	14.9	67	-41
February	16.3	63	-39
March	27.1	80	-29
April	40.2	88	-9
May	52.2	94	3
June	61.5	98	24
July	66.3	100	34
August	63.9	97	20
September	56.5	94	8
October	46.0	88	8
November	33.6	77	-13
December	19.8	66	-44
Annual	41.8	100	-44

Errol, New Hampshire
Elevation 1280 Ft. MSL
9 Years - 1932 thru 1941

<u>Month</u>	<u>Mean</u>	<u>Max.</u>	<u>Min.</u>
January	16.9	53	-30
February	18.6	49	-24
March	27.2	64	-20
April	40.1	78	5
May	51.9	88	26
June	61.7	92	32
July	66.4	92	44
August	64.0	90	36
September	56.0	87	24
October	44.9	78	18
November	34.3	68	-6
December	21.6	60	-32
Annual	42.0	92	-32

TABLE B-4

MONTHLY PRECIPITATION RECORD
(in inches)

Lewiston, Maine
Elevation 182 Ft. MSL
88 Years of Record

<u>Month</u>	<u>Mean</u>	<u>Max.</u>	<u>Min.</u>
January	3.86	8.70	1.22
February	3.59	6.44	1.29
March	4.19	11.13	1.01
April	3.58	7.67	0.42
May	3.41	7.45	0.57
June	3.37	6.54	0.78
July	3.52	7.33	0.93
August	3.06	7.30	0.70
September	3.56	10.44	0.91
October	3.59	7.55	0.08
November	4.09	7.87	0.57
December	3.93	7.85	1.01
Annual	43.75	61.13	25.61

Rumford, Maine
Elevation 674 Ft. MSL
69 Years of Record

<u>Month</u>	<u>Mean</u>	<u>Max.</u>	<u>Min.</u>
January	2.91	4.79	0.98
February	2.69	4.87	0.85
March	3.34	13.06	0.91
April	3.26	6.72	0.48
May	3.39	8.43	0.69
June	3.45	7.35	1.31
July	3.71	6.20	0.98
August	3.27	6.44	0.97
September	3.56	9.06	0.33
October	3.34	8.41	0.04
November	3.68	8.25	0.61
December	3.08	6.37	0.83
Annual	39.69	62.36	34.44

Berlin, New Hampshire
Elevation 1110 Ft. MSL
62 Years of Record

<u>Month</u>	<u>Mean</u>	<u>Max.</u>	<u>Min.</u>
January	2.89	7.15	0.76
February	2.57	3.35	0.89
March	3.20	10.46	0.75
April	2.85	6.05	0.47
May	3.09	6.58	1.12
June	3.74	7.50	1.63
July	3.55	6.08	1.18
August	3.33	6.96	0.74
September	3.51	12.26	0.62
October	3.14	7.40	0.46
November	3.53	8.11	0.73
December	3.04	5.79	0.89
Annual	38.46	58.00	28.96

Errol, New Hampshire
Elevation 1280 Ft. MSL
74 Years of Record

<u>Month</u>	<u>Mean</u>	<u>Max.</u>	<u>Min.</u>
January	2.82	5.05	1.02
February	2.59	4.37	1.18
March	2.80	6.78	0.84
April	2.83	5.51	0.52
May	3.11	7.45	1.25
June	3.91	9.20	0.87
July	3.81	7.82	1.11
August	3.69	6.65	1.23
September	3.47	7.95	1.02
October	3.17	5.93	0.91
November	3.77	6.62	0.71
December	2.88	5.12	1.11
Annual	38.25	57.69	34.44

TABLE B-5

MEAN MONTHLY SNOWFALL
Depth in Inches

Lewiston, Maine
Elevation 182 Ft. MSL
74 Years of Record

Rumford, Maine
Elevation 674 Ft. MSL
56 Years of Record

<u>Month</u>	<u>Snowfall</u>	<u>Month</u>	<u>Snowfall</u>
January	20.7	January	22.0
February	21.0	February	21.2
March	13.6	March	16.2
April	5.6	April	6.2
May	0.3	May	0.3
June	0.0	June	0.0
July	0.0	July	0.0
August	0.0	August	0.0
September	0.0	September	0.0
October	0.2	October	0.5
November	6.3	November	7.6
December	14.3	December	18.8
Annual	82.4	Annual	90.8

Berlin, New Hampshire
Elevation 1110 Ft. MSL
61 Years of Record

<u>Month</u>	<u>Snowfall</u>
January	22.6
February	21.9
March	20.6
April	7.0
May	0.4
June	0.0
July	0.0
August	0.0
September	0.0
October	1.2
November	9.9
December	18.0
Annual	101.6

e. Storms.

(1) General. Three general types of storms occur in the Androscoggin River basin: Extratropical cyclones, tropical hurricanes, and rainstorms caused by the orographic influence of the mountain ranges on a relative moist air mass.

(2) March 1936 Storm. A succession of two storms within a period of 11 days caused heavy rains throughout the entire New England area. Rainfall for the period 10-20 March varied from a few inches along the coast to a maximum of about 20 inches in the White Mountains.

(3) March 1953 Storm. A main upper air low pressure system extending over the northeastern United States dominated the region's weather during the latter part of March. It drifted very slowly eastward and favored the development of four coastal storms and their intensification as they approached New England. Consequently, a practically steady flow of moist ocean air streamed over New England producing almost continuous precipitation during an eight day period extending from 24-31 March. Rainfall amounting to over nine inches was recorded at Pinkham Notch in the White Mountain Region.

(4) October 1959 Storm. A blocking high southeast of Newfoundland impeded the forward progress of a small storm off the Carolina coast and forced it to move slowly northwestward toward an intense disturbance over Michigan. The coastal storm intensified as it moved northwestward bringing strong southeast winds into the New England area. The strong winds picked up a considerable amount of moisture as they swept across the ocean and the moisture was deposited in the form of rain especially over the mountainous areas. In this storm of 23-26 October over 10 inches of rain was recorded at Pinkham Notch in the White Mountains.

5. STREAMFLOW

The U.S. Geological Survey has maintained and published records of fourteen stream gaging stations in the Androscoggin River basin. Nine stations are presently in operation, all of which are water-stage recorders as shown on Table B-6. Records of flow at Rumford are determined from gage readings furnished by the Rumford Falls Power Company.

TABLE B-6

STREAMFLOW RECORDS - ANDROSCOGGIN RIVER BASIN

<u>Location of Gaging Station</u>	<u>Drainage Area (sq. mi.)</u>	<u>Period of Record</u>	<u>Discharge (cfs)</u>		
			<u>Mean</u>	<u>Maximum</u>	<u>Minimum</u>
Diamond River nr. Wentworth Location, N.H.	153	1941-	342	8,630 6/16/43	6.8
Androscoggin River at Errol, N.H.	1,045	1905-	1,885	15,700 * 6/18/43	Leakage
Androscoggin River at Berlin, N.H.	1,350	1913- 1928	2,313	20,000 6/18/17	960 *
Androscoggin River at Gorham, N.H.	1,363	1928-	2,444	20,000 * 4/30/23	456
Androscoggin River at Rumford, Maine	2,067	1892	3,681	74,000 3/20/36	625 *
Swift River nr. Roxbury, Maine	95.8	1929-	196	16,800 10/24/59	3.8
Nezinscot River at Turner Center, Maine	171	1941-	298	13,900 3/27/53	5.6
Little Androscoggin River nr. South Paris, Maine	76.2	1913- 1924; 1931-	137	8,000 3/27/53	1
Little Androscoggin River nr. Auburn, Maine	328	1940-	549	16,500 3/28/53	14 *
Androscoggin River nr. Auburn, Maine	3,257	1928-	5,989	135,000 3/20/36	340 *

* Daily Discharge

6. LOW FLOW

Regulation of the storage in the Rangeley Lakes for power generation at downstream stations along the Androscoggin River insures a flow of about one cubic foot per second per square mile (csm) about 90 percent of the time. Releases from the Rangeley Lakes with the exception of Kennebago Lake, are controlled by the Union Water Power Company, a subsidiary of the Central Maine Power Company. In accordance with an agreement between the company and several of the downstream water users, a minimum flow of 1550 cfs is maintained at the USGS gage at Gorham insofar as possible. Flows below the desired minimum have occurred occasionally, notably during low flow periods of 1930-31, 1941-42 and 1947-48. The minimum observed daily flow at Gorham was 795 cfs on 15 March 1948.

7. FLOODS OF RECORD

a. Historic Floods. The history of floods in the Androscoggin River basin goes back nearly 179 years with records indicating the occurrences of floods in 1785, 1814, 1820, 1826, 1827, 1846 and 1869. The longest period of flow records has been maintained by the Rumford Falls Power Company at Upper Falls, Rumford, Maine where systematic records were started in 1892.

b. Recent Floods. The March 1936 flood was the greatest flood of record in the lower reaches of the Androscoggin River. This flood was caused by unseasonably warm temperatures and heavy rain on top of the snow cover. Flooding at several locations was further aggravated by severe ice jams. Two distinct storms occurred in March. During the first storm, occurring from 9 to 14 March, 5.8 inches of rainfall was recorded in Rumford, Maine and 8.8 inches at Pinkham Notch, New Hampshire. During the second storm, occurring from 16 to 23 March, 5.8 inches was recorded at Rumford and 13.7 inches at Pinkham Notch. The second storm produced the highest recorded peak flow at 74,000 c.f.s. at Rumford and the largest flood losses ever experienced in the basin.

The March 1953 flood is the second largest general basin flood that has occurred in recent years. Precipitation occurred during most of the month culminating with an average of about five inches between 24-27 March. A major flood and severe damages were experienced along the entire length of the main river from Berlin to Brunswick and along several tributary streams. The recorded peak flow at Rumford was 56,700 c.f.s.

The October 1959 flood produced record peak discharges on the tributaries that drain between Berlin and Rumford. At the USGS gage on the Swift River near Roxbury, Maine (D.A. = 95.8 sq. mi.) the recorded record peak flow was 16,800 c.f.s. or 176 c.s.m. The limited areal extent of the storm prevented development of a major flood on the main stem of the river.

Nine floods of sufficient magnitude to cause significant damage have occurred in the basin. The dates and magnitude of these floods at Rumford are shown in Table B-7.

TABLE B-7

MAJOR FLOODS

ANDROSCOGGIN RIVER BASIN

<u>Flood</u>	<u>Maximum Daily Discharge</u> (cfs)	<u>Peak Discharge</u> (cfs)
20 March 1936	68,300	74,000
15 April 1895	55,230	(not known)
28 March 1953	52,700	56,700
25 October 1959	41,700	46,800
5 November 1927	39,100	46,700
2 March 1896	39,010	(not known)
25 November 1963	31,500	35,400
27 November 1950	31,100	33,400
15 June 1942	26,600	30,200

c. Flood Profiles. High water profiles determined for the Androscoggin River from field surveys following the flood of March 1936 are shown on Plate Nos. B-2, B-3, and B-4.

d. Flood Frequencies. Peak discharge-frequency curves were computed for all gaging stations in the basin. The frequency analyses were made in accordance with the procedures outlined in EM 1110-2-1450. The method assumes that the logarithmic values of annual peak flows are normally distributed, thereby permitting the application of standard statistical analysis. This enables the discharge-frequency curve to be defined by its mean value and standard deviation. Based on a regional analysis, a skew coefficient of 1.0 was adopted for the Androscoggin River basin. The basic frequency data for gaging stations was used to derive frequency curves applicable to the damage zones for economic studies. A tabulation of the natural frequency curve data for the damage zones is shown in Table B-8. Frequency curves at various gaging stations along the main stem are shown on Plate No. B-6.

8. ANALYSIS OF FLOODS

a. General. The major floods of record were analyzed to determine the hydrologic development of the floods and the tributary components contributing to the crests on the main river. Such a study is essential to appraise the flood potentialities of the basin and to determine tributaries which should be controlled to obtain the most effective flood reductions.

b. Flood Routing. Because of its simplicity in deriving routing coefficients and its adaptability for component routing, the progressive average-lag method of flood routing was adopted for all reaches except between Rumford and Auburn. A variable coefficient routing method was used between these two zones. The Androscoggin River basin was divided into tributary watershed and subareas for flood analysis as shown on Plate No. B-1. The routing coefficients were obtained by trial from the floods of record and were selected on the basis of the best reproduction of the recorded hydrographs.

c. Analysis of Floods. The results of the flood analyses are shown graphically on Plate Nos. B-20 and B-21 for the 1936 and 1953 floods. The discharge contribution of the tributary areas to the peak discharge at selected index stations are tabulated in Table B-9 and are described as follows:

TABLE B-8
ANDROSCOGGIN RIVER
TABULATION OF NATURAL FREQUENCY CURVE DATA
FOR
DAMAGE ZONES

ZONES												
Exceedence Freq. per 100 years	Exceedence Interval in years	1,2& 3 Auburn (USGS Gage)	4 & 5 Rt. 202 Hwy Bridge	6,7 & 8 Livermore Falls Dam	9 & 10 Ridgdonville Hwy Bridge	11 Rumford Upper Falls	12 Bethel	13 West Bethel	14a-1 Shelburne Falls Dam	14a-2 N.H.P.S. Co. Dam	14b,15 & 16 Gorham (USGS Gage)	17 Errol Dam
		RM 28.4	RM 30.6	RM 61.8	RM 85.6	RM 88	RM 105	RM 113	RM 127.6	RM 130.3	RM 134.4	RM 168.6
.05	2,000	250,000	220,000	180,000	165,000	145,000	120,000	102,000	64,000	43,500	28,000	19,000
.10	1,000	218,000	190,000	155,000	140,000	125,000	105,000	91,500	59,000	40,500	26,800	18,400
.25	400	177,000	155,000	128,000	115,000	104,000	87,000	80,000	53,000	36,900	25,000	17,500
.50	200	152,000	130,000	108,000	96,000	87,000	76,000	68,000	46,800	34,000	23,500	16,700
1.00	100	122,000	108,000	90,000	81,000	74,000	65,000	59,000	42,000	31,000	22,100	15,900
1.25	80	114,000	100,000	85,000	76,000	70,000	62,500	57,000	40,400	30,200	21,900	15,500
1.50	66.7	108,000	95,000	81,000	73,000	67,000	60,000	55,000	39,200	29,700	21,400	15,300
2.0	50	100,000	87,000	76,000	67,500	63,000	56,000	52,000	37,200	28,400	20,700	14,900
3.0	33.3	87,000	77,000	68,000	61,000	57,000	51,000	47,000	34,800	26,800	19,800	14,200
4.0	25	80,000	71,000	63,000	57,000	53,000	48,000	44,000	33,000	25,500	19,000	13,800
5.0	20	74,100	67,000	60,000	54,000	50,000	45,500	42,000	31,600	24,800	18,500	13,500
10.0	10	62,400	55,000	50,000	46,000	42,000	38,500	35,200	27,200	21,800	16,900	12,100
20.0	5	51,600	46,000	41,000	38,000	35,700	32,000	29,200	23,100	18,700	15,100	10,500
30.0	3.3	46,100	41,000	36,700	34,000	32,000	28,000	26,000	20,800	16,900	14,100	9,400
40.0	2.5	42,500	38,000	34,000	31,500	29,800	25,500	23,600	19,000	15,700	13,400	8,500
50.0	2	39,700	36,000	31,600	29,300	27,800	23,200	21,900	17,600	15,000	12,800	8,000
60.0	1.7	37,700	34,000	30,000	28,000	26,400	22,200	20,500	16,800	14,100	12,200	7,500
70.0	1.4	36,000	33,500	28,600	27,000	25,200	21,300	19,600	15,900	13,600	11,700	7,200
80.0	1.25	34,500	31,200	27,500	26,000	24,200	20,900	19,000	15,200	13,000	11,000	6,900
90.0	1.11	33,200	30,000	26,500	25,000	23,200	20,000	18,300	14,500	12,500	10,500	6,600
95.0	1.05	32,800	29,600	26,000	24,500	22,900	19,800	18,000	14,100	12,100	10,300	6,500
99.0	1.01	32,300	29,000	25,500	24,000	22,600	19,100	17,300	13,600	11,800	10,200	6,200
99.99	1+	32,200	28,800	25,000	23,900	22,500	19,000	16,900	13,000	11,500	10,100	6,000

TABLE B-9
TRIBUTARY CONTRIBUTIONS
TO
MAIN RIVER FLOOD PEAKS
ANDROSCOGGIN RIVER BASIN, ME. & N.H.

Location	Contributing Component	Drainage Area (sq.mi.) (%)		Discharge				TTCF	
				March 1936 (c.f.s.) (%)		March 1953 (c.f.s.) (%)		(c.f.s.) (%)	
Gorham, N.H.	Androscoggin at Errol	1,045	76.7	5,500	28.8	2,300	13.0	2,000	10.0
	Local - Errol to Gorham	318	23.3	13,600	71.2	15,400	87.0	18,000	90.0
		1,363	100.0	19,100	100.0	17,700	100.0	20,000	100.0
Rumford, Me.	Androscoggin at Errol	1,045	50.5	4,100	5.5	1,000	1.8	2,800	4.5
	Local - Errol to Gorham	318	15.4	10,200	13.8	6,900	12.6	8,200	13.1
	Moose & Peabody Rivers (1)	95	4.6	12,900	17.4	4,500	8.2	8,700	14.0
	Local Area	65	3.1	5,000	6.8	3,400	6.2	3,200	5.1
	Wild River	69	3.3	10,100	13.6	3,700	6.7	6,600	10.6
	Local Area	99	4.8	9,000	12.2	8,400	15.3	8,200	13.1
	Sunday River	51	2.5	4,300	5.8	4,400	8.0	3,900	6.2
	Local Area	22	1.1	1,600	2.2	1,900	3.4	1,500	2.4
	Bear River	43	2.1	3,000	4.0	3,700	6.7	2,800	4.5
	Local Area	32	1.6	2,300	3.1	2,700	4.9	2,700	4.3
	Ellis River	163	7.9	9,300	12.6	9,000	16.4	10,700	17.2
	Local Area	65	3.1	2,200	3.0	5,400	9.8	3,100	5.0
		2,067	100.0	74,000	100.0	55,000	100.0	62,400	100.0
Auburn, Me.	Androscoggin at Errol	1,045	32.2	3,700	3.1	6,500	6.5	2,800	2.9
	Local - Errol to Gorham	318	9.7	9,100	7.7	1,000	1.0	6,600	6.8
	Moose & Peabody Rivers (1)	95	2.9	9,800	8.3	4,100	4.1	6,500	6.7
	Local Area	65	2.0	3,900	3.3	3,000	3.0	2,400	2.5
	Wild River	69	2.1	7,900	6.7	3,200	3.2	4,800	5.0
	Local Area	99	3.0	7,500	6.4	6,800	6.8	6,400	6.6
	Sunday River	51	1.6	3,600	3.0	3,600	3.6	3,000	3.1
	Local Area	22	0.7	1,300	1.1	1,500	1.5	1,200	1.2
	Bear River	43	1.3	2,600	2.2	3,000	3.0	2,100	2.2
	Local Area	32	1.0	2,200	1.9	1,600	1.6	2,400	2.5
	Ellis River	163	5.0	8,800	7.5	8,500	8.5	9,400	9.7
	Local Area	65	2.0	2,800	2.4	4,400	4.4	3,600	3.7
	Sub-total Androscoggin above Rumford	2,067	63.5	63,200	53.6	47,200	47.2	51,200	52.9
	Swift River	125	3.8	11,400	9.7	7,500	7.5	8,500	8.8
	Webb River (2)	145	4.5	4,800	4.0	3,700	3.7	4,100	4.2
	Local Area	159	4.9	7,100	6.0	4,400	4.4	6,700	6.9
	Local Area	164	5.0	3,300	2.8	4,500	4.5	6,200	6.4
	Nezinscot River	181	5.6	8,300	7.0	13,500	13.5	6,200	6.4
	Local Area	63	1.9	3,500	3.0	2,700	2.7	2,000	2.0
	Little Androscoggin River	353	10.8	16,400 (3)	13.9	16,500	16.6	12,000	12.4
		3,257	100.0	118,000 (3)	100.0	99,900	100.0	96,900	100.0

(1) Includes 24 sq. mi. of local area.

(2) " 13 " " " " " "

(3) Adjusted for effect of ice jam.

(1) Above Errol Dam. The flood runoff from the area above Errol Dam is greatly modified by the large amount of storage in lakes which are usually filled during the spring runoff season of March, April and May. The total usable capacity of the lake storage is about 661,000 acre-feet, which is equivalent to almost 12 inches of runoff from the entire 1045 square miles.

Only during major floods, similar to March 1936, is there an appreciable amount of flood flow from the lake area. The drainage area of 1045 square miles above Errol Dam represents nearly 50 percent of the watershed above Rumford but contributes less than five percent to the peak flow. At Auburn, the 1045 square miles above Errol represents about one-third of the total drainage area but contributes less than three percent to the peak flow.

(2) Errol to Gorham. This area comprises 318 square miles and represents about 23 percent of the drainage area at Gorham. The peak at Gorham is usually generated by the flood flow from this area with the outflow from the Rangeley Lakes area arriving a few days later. At Gorham, the flood hydrograph is double peaked. The first, usually the higher, represents the runoff from the 318 square miles while the second peak, usually the lower, represents the runoff from the Rangeley Lakes area. Runoff from the 318 square miles contributes about 13 percent to the flood peak at Rumford and about seven percent to the flood peak at Auburn.

(3) Gorham to Rumford, Maine. The principal flood-producing tributaries drain the slopes of the White Mountains and are located in the central portion of the basin. Major flood contributors are the Moose, Peabody, Wild and Swift Rivers which drain a total of about 265 square miles. At Auburn this represents eight percent of the gross drainage and 12 percent of the net drainage area (excluding the area above Errol). These four streams, however, contribute on the average about 20 percent to the peak flow. The Sunday and Bear Rivers also are large flood contributors.

Because of the large amount of natural storage on the lower portion of the Ellis River, its contributions to flood flows is uncertain. Three gaging stations have been placed in operation to help analyze the concurrent flows on the Ellis and Androscoggin Rivers during flood periods. (See paragraph 11a for further discussion on this subject.)

(4) Rumford, Maine to Mouth. The Nezinscot and Little Androscoggin Rivers are the large flood contributors from the lower portion of the basin. These two tributaries drain about 24 percent of the net drainage area at Auburn and contribute about that same amount to the peak flow.

9. TYPICAL TRIBUTARY CONTRIBUTION FLOOD

a. General. To evaluate the relative flood control effectiveness of various plans, a synthetic flood was developed to represent typical contributions from all principal tributaries in the Androscoggin River basin. It is called the "Typical Tributary Contribution Flood" (TTCF). The TTCF was developed in accordance with the method set forth in the NENYIAC Report, Part Three, Volume 3, Section XIX.

b. Storm. The storm producing the TTCF was assumed to be distributed throughout the basin in an isohyetal pattern approximating that of the average annual precipitation. A study of the storms producing the four floods analyzed in the Androscoggin River basin (March 1936, June 1942, November 1950 and March 1953 floods) showed some variations from the average annual rainfall pattern. Allowance for these variations was made in deriving the tributary components of the TTCF. The volume of runoff for each tributary hydrograph was assumed to be about 10 percent of the average annual rainfall.

c. Discharge. In the development of the TTCF, it was assumed that the areas under the tributary discharge-frequency curves best indicate the relative flood-producing potential of each tributary. The peak flows of the TTCF on the tributaries therefore were related to the areas under the discharge-frequency curves when plotted on arithmetic probability paper. The probability limits for area measurement were assumed to be between 50 percent chance of occurrence (2 years) and 0.05 percent (2,000 years). Selection of these limits were based on the fact that the 50 percent probability flood represents the approximate beginning of damages while the 0.05 percent probability is the upper limit considered in economic analysis. The area under frequency curves for each tributary was related to that of an index station and expressed in terms of percentage. The Androscoggin River at Auburn was selected as the index station with an approximate peak discharge of 100,000 cfs.

d. Timing of TTCF. To determine the timing of the TTCF, a study was made of the relative timing of the tributary peaks from analysis of the past floods of record. An average timing was then selected for each tributary peak.

The typical tributary contribution flood hydrographs at selected locations are shown on Plate B-22. The discharge contributions of the tributary areas to the peak discharge at the index stations are tabulated in Table B-9 and shown graphically on Plate B-22.

10. PONTOOK PROJECT

a. General. The plan discussed in the main report consists of Pontook Dam and Reservoir with a reregulating dam and pool. Plate 2 of the main report shows a reservoir map of the Pontook project with area and capacity curves. This project, located on the Androscoggin River about 12 miles upstream of Berlin, New Hampshire, would be developed for power, flood control, and recreation. Storage in Pontook would be operated in conjunction with the storage available in the existing reservoirs in the Rangeley Lakes system.

b. Storage. Pontook Reservoir would have a gross storage capacity of 238,000 acre-feet. Allocation of this storage is as follows:

	<u>Elevation</u> (feet)	<u>Storage</u> (acre-feet)
Dead	1,180	31,000
Power, Flood Control and recreation	1,220	<u>207,000</u>
Total		238,000

(1) Flood control storage. Pontook Dam would be operated for multiple-purpose use in conjunction with the storage available in the Rangeley Lakes system. As shown on Plate F-2 of Appendix F, varying amounts of storage would be reserved monthly for flood control in all storage reservoirs. The amount would be dependent on the season, with the maximum occurring in the spring months and minimum during the summer months.

In the spring, a minimum of 98,400 acre-feet of storage would be provided at Pontook Reservoir, equivalent to about 10.9 inches of runoff from its net drainage area of 170 square miles. In Umbagog Lake, upstream of Errol Dam, 70,700 acre-feet of storage would be available during the spring for flood regulation. The combination of Umbagog and Pontook storage would provide a minimum of 6 inches of storage in the spring from a net drainage area of 529 square miles. Other lakes in the system also would be drawn down during this period, thus providing a total of 283,700 acre-feet of storage for flood regulation which is equivalent to about 4.4 inches of runoff over the entire drainage area of 1,215 square miles. Based on late winter and early spring snow surveys, the system storage could be increased to about 8 inches of runoff without falling below the power operating rule curve.

Similar to the present regulation of the Rangeley Lakes, the entire system would generally be filled in the late spring. The flood control effectiveness of the system during this fill period decreases as the amount of available storage is reduced. Floods occurring during the summer months, when the reservoirs are full, would be considerably modified by use of induced surcharge storage. Although some moderate flooding has been experienced in the upper Androscoggin River during the month of June, as shown in Tables B-6 and B-7 no flooding has occurred on the main river during July or August.

(2) Power storage. From mass curve and low flow analyses, it was determined that 207,000 acre-feet of usable storage at Pontook, together with the 661,000 acre-feet in the Rangeley Lakes, would provide a minimum dependable flow of 1,724 cfs at Pontook. Mass curves were developed from USGS gage records of observed and natural flows at Errol Dam (drainage area= 1,045 square miles) and at Gorham (drainage area= 1,363 square miles). Streamflow records have been maintained by the USGS at Errol since 1905 and at Gorham since 1913. A detailed analysis of power storage is given in Appendix F.

(3) Dead storage. A minimum pool at elevation 1180, with 31,000 acre-feet of storage, would provide a minimum net operating power head of 57 feet.

c. Spillway design flood. In deriving the spillway design flood for Pontook Reservoir, the drainage area was divided into three components:

(1) the areas upstream of both Aziscohos Dam and Middle Dam on Lower Richardson Lake (drainage area = 686 square miles); (2) the area downstream of Aziscohos and Middle Dams and upstream of Errol Dam (drainage area = 359 square miles); and (3) the area between Errol Dam and Pontook Dam. The adopted spillway design flood for Pontook Reservoir is illustrated on Plate B-19. Because of the large amount of storage in the lakes upstream of Aziscohos and Middle Dams, the spillway design flood from this area would be greatly reduced and would not synchronize with the spillway design flood at Pontook.

A spillway design flood was computed for the net area upstream of Errol Dam (drainage area = 359 square miles). This flood was routed through the surcharge storage at Umbagog Lake and added to the spillway design flood computed for the 170 square miles that drains the area between Errol and Pontook Dams.

(1) Unit hydrographs. Three-hour unit hydrographs were derived for the 359 square miles of drainage area above Errol Dam, and for the 170 square miles of drainage area between Errol and Pontook Dams. The 170 square miles was separated into Clear Stream (drainage area = 65 square miles) and the reservoir peripheral area of 105 square miles. The unit hydrographs were based on a unit hydrograph study of the Swift River near Roxbury, Maine (drainage area = 95.8 square miles). Runoff data for the Diamond River near Wentworth Location, New Hampshire (drainage area = 153 square miles) was investigated but was found to be unsuitable for unit hydrograph analysis. For the Swift River, unit hydrographs were derived for the following floods: June 1942, June 1943, November 1950, September 1954 and October 1959.

The results of these studies are shown on Plate Nos. B-7 through B-17. Based on these studies, the peaks of the adopted 3-hour unit hydrographs for deriving a spillway design flood were selected at about 8 $\frac{1}{2}$ csm or 15 percent greater than the highest derived unit hydrograph peak. The time of concentration varied from 3 hours to 5 hours. The adopted three-hour unit hydrographs for Pontook Reservoir are shown on Plate No. B-18. A comparison of the adopted values for Pontook Reservoir and other reservoir sites in New England is given in Table B-10.

(2) Probable maximum precipitation. The probable maximum precipitation was taken from Hydrometeorological Report No. 33. It was assumed that the storm was centered over the 170 square miles between Errol and Pontook Dams, while the 359 square miles above Errol Dam received the residual rainfall. Infiltration and other losses were assumed at a rate of 0.20 inch per three hours. Data for the probable maximum precipitation, losses and excesses are tabulated in Table B-11. Should the project be designed, consideration would be given to reducing the precipitation values based on criteria discussed in OCE letter dated 10 April 1964 concerning the Hop Brook Hydrology Design Memo.

(3) Spillway design inflow. The spillway design flood inflow to Pontook of 190,000 cfs was computed by applying rainfall excesses to adopted unit hydrographs. Of this total, 167,000 cfs is contributed by the area downstream of Errol Dam, and 23,000 cfs is contributed by the area upstream of Errol Dam.

TABLE B-10

UNIT HYDROGRAPH RELATIONSHIPS

<u>Location</u>	<u>Drainage Area sq. mi.</u>	<u>3-Hr. Unit Hydrograph Design Flood</u>		<u>W-50</u>	<u>W-75</u>	<u>640 Cpr</u>	<u>Tpr</u>
		<u>cfs.</u>	<u>csm.</u>	<u>hrs.</u>	<u>hrs.</u>		
Clear Stream	65	5,500	8 $\frac{1}{2}$	6.0	3.5	378	4.5
Pontook	105	8,800	8 $\frac{1}{2}$	6.0	4.0	252	3.0
(peripheral)							
Errol (Net)	359	27,000	75	6.0	3.5	420	5.0
Swift River	95.8	7,000	73	6.5	4.0	547	7.5
Otter Brook	47	2,080	44	8.5	5.5	352	8.0
North Hartland	220	17,160	78	4.0	3.0	390	5.0
North Spring - field	123	10,750	87	5.0	2.5	565	6.5

TABLE B-11

PROBABLE MAXIMUM PRECIPITATION

Pontook Reservoir Net Area 170 Sq. Mi.					Umbagog Lake * Net Area 359 Sq. Mi.			
TIME hrs.	Rainfall in.	Losses in.	Rainfall Excess(in.)	Rainfall Pattern(in.)	Rainfall in.	Losses in.	Rainfall Excess(in.)	Rainfall Pattern (in.)
0	0	0	0	0	0	0	0	0
3	10.5	0.2	10.3	0.1	7.4	0.2	7.2	0.3
6	2.6	0.2	2.4	0.4	1.8	0.2	1.6	0.43
9	1.5	0.2	1.3	1.3	1.5	0.2	1.3	1.3
12	1.0	0.2	0.8	10.3	1.07	0.2	0.87	7.2
15	0.6	0.2	0.4	2.4	0.63	0.2	0.43	1.6
18	0.6	0.2	0.4	0.8	0.50	0.2	0.3	0.87
21	0.4	0.2	0.2	0.4	0.50	0.2	0.3	0.3
24	0.3	0.2	0.1	0.2	0.36	0.2	0.16	0.16
27	0.3	0.2	0.1	0.1	0.20	0.2	0	0
30	<u>0.2</u>	<u>0.2</u>	<u>0</u>	<u>0</u>	<u>0.20</u>	<u>0.2</u>	<u>0</u>	<u>0</u>
Total	18.0	2.0	16.0	16.0	14.16	2.0	12.16	12.16

* Area between Richardson and Aziscohos Lakes and
Errol Dam

d. Spillway design flood discharge. The spillway design flood discharge was computed by routing the design inflow through the reservoir with the following assumptions: the reservoir was full to elevation 1220 at the beginning of the flood with one turbine discharging a flow of 14,000 cfs. The three tainter gates, each 40 feet wide would be operated to induce a surcharge of about 4 feet to elevation 1224. A spillway discharge of 138,000 cfs would occur resulting in a total outflow of about 152,000 cfs. Plate B-19 shows the routing of the spillway design flood.

Consideration was given to the effect of a failure of the upstream Errol Dam. From a study of river cross sections, it was estimated that the channel downstream of Errol Dam would limit the discharge to about 50,000 cfs. In order to take into account the failure or redevelopment of Errol Dam, later studies should consider the possibility of more than one turbine making flood releases under this extreme condition.

e. Freeboard. The freeboard was computed using the method outlined in Technical Memorandum No. 132 entitled: "Waves in Inland Reservoirs", November 1962. For an assumed maximum wind of 80 miles per hour, the computed freeboard was 4.0 feet. For this report, a minimum of six feet was adopted.

f. Flood discharge outlets. The three turbine intakes to the power house, shown on Plate 4, would act as discharge outlets when necessary during periods of flooding and to supplement spillway discharges. Each turbine would be designed for a full load discharge of 14,000 cfs. Should the dam be constructed, the intakes would provide adequate diversion capacity.

g. Reregulating dam. Since power would be developed at Pontook Dam at a low load factor, a second dam would be constructed about 6.5 miles downstream to reregulate the peak turbine discharges to usable flows for downstream plants. The pool, extending upstream to the main dam, would have a capacity of 16,300 acre-feet at full pool elevation of 1121. Three tainter gates each 45 feet wide would be used to discharge both flood flows and reregulated power releases. A 6' x 20' gate for a log sluiceway would be included. Details of the regulating dam are shown on Plate 4 of the main report.

During large floods, high tailwater elevations would exist due to the extreme flatness of the river downstream of the dam and small head differentials would occur between the headwater and tailwater conditions. The degree of security to the dam would be consistent with Standard 2 as described in EC 1110-2-27, dated 1 August 1966, whereby the structure can be overtopped during rare floods without failing and without suffering serious damage. The dam would be designed to discharge a flow of 75,000 cfs with a head differential of about 3 feet between headwater (1133 ft. msl) and tailwater (1130 ft. msl). The tainter gates would be operated from the power house based on discharges from the main dam.

h. Reservoir regulation. Pontook Dam will be regulated to reduce flood flows along the Androscoggin River during flood periods, generate power, and, together with the reregulating dam, provide a minimum dependable flow from the watershed even during extreme dry periods.

(1) Flood regulation. Pontook Reservoir flood control storage will be regulated with the reservoirs in the Rangeley Lakes system to control the flood runoff from the 1,215 square miles of drainage area at Pontook Dam. Stage and discharge reductions will be afforded by this regulation at the major damage centers along the Androscoggin River such as Berlin and Gorham, New Hampshire and Rumford, Mexico, Lewiston and Auburn, Maine. A tentative method of regulation was prescribed and tested on the record March 1936 flood which produced an unusually high volume of runoff from the entire watershed.

For this regulation study, it was assumed that all storage reservoirs had been drawn at the beginning of the flood based on snow surveys. (Development of system rule curves is discussed in Appendix F.) By restricting the outflow to an average power release rate of 1,724 c.f.s. during the initial development of the flood, it was possible to attain substantial flood reductions at downstream damage centers. When the flood peak at Rumford began to recede, the outflow was increased to 8,000 c.f.s. which was maintained until the end of April when the entire system would have receded to the system rule curve. Under the method of operation, Pontook Reservoir would rise to elevation 1,221 or one foot above full pool.

Regulation of the 1936 flood and the effect at downstream damage centers are shown on Plate No. B-23. Discharge reductions at selected locations are given in Table B-12.

TABLE B-12

MARCH 1936 FLOOD
EFFECT OF PONTOOK RESERVOIR REGULATION
AND REREGULATION OF UPSTREAM STORAGE RESERVOIRS

<u>Location</u>	<u>Observed</u> (c.f.s.)	<u>Modified</u> (c.f.s.)	<u>Reduction</u> (c.f.s.)	(%)
Pontook Dam	16,000	8,000*	8,000	50.0
Berlin, N. H.	19,900	12,000**	7,900	39.6
Rumford, Maine	74,000	66,500	7,500	10.1
Auburn, Maine	118,000	113,000	5,000	4.2

*During development of flood, outflow curtailed to minimum power requirements of 1,724 c.f.s.

**During development of flood, with flow from Pontook curtailed to 1,724 c.f.s., flow at Berlin would be 9,000 c.f.s. After flood crest has passed downstream damage centers, releases from Pontook would be increased so that flow at Berlin would not exceed 12,000 c.f.s. (safe channel capacity).

(2) Low flow regulation. Average monthly flow records at the Gorham gage show that, of the 312 months studied between 1938 and 1963, 22 months showed flows less than the minimum 1,550 cfs which is desired at Gorham by the water users on the river, the lowest flow being 1,257 cfs. The reregulating dam at Pontook would provide a minimum dependable release of 1,724 c.f.s.

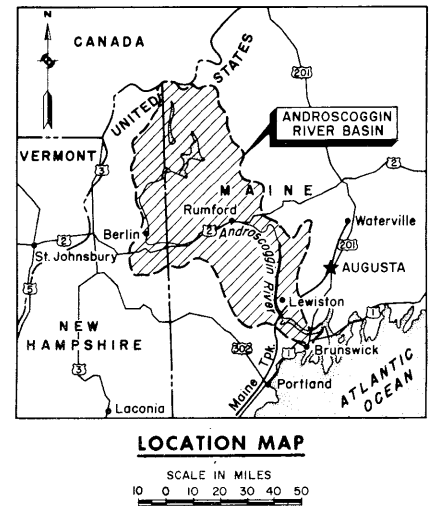
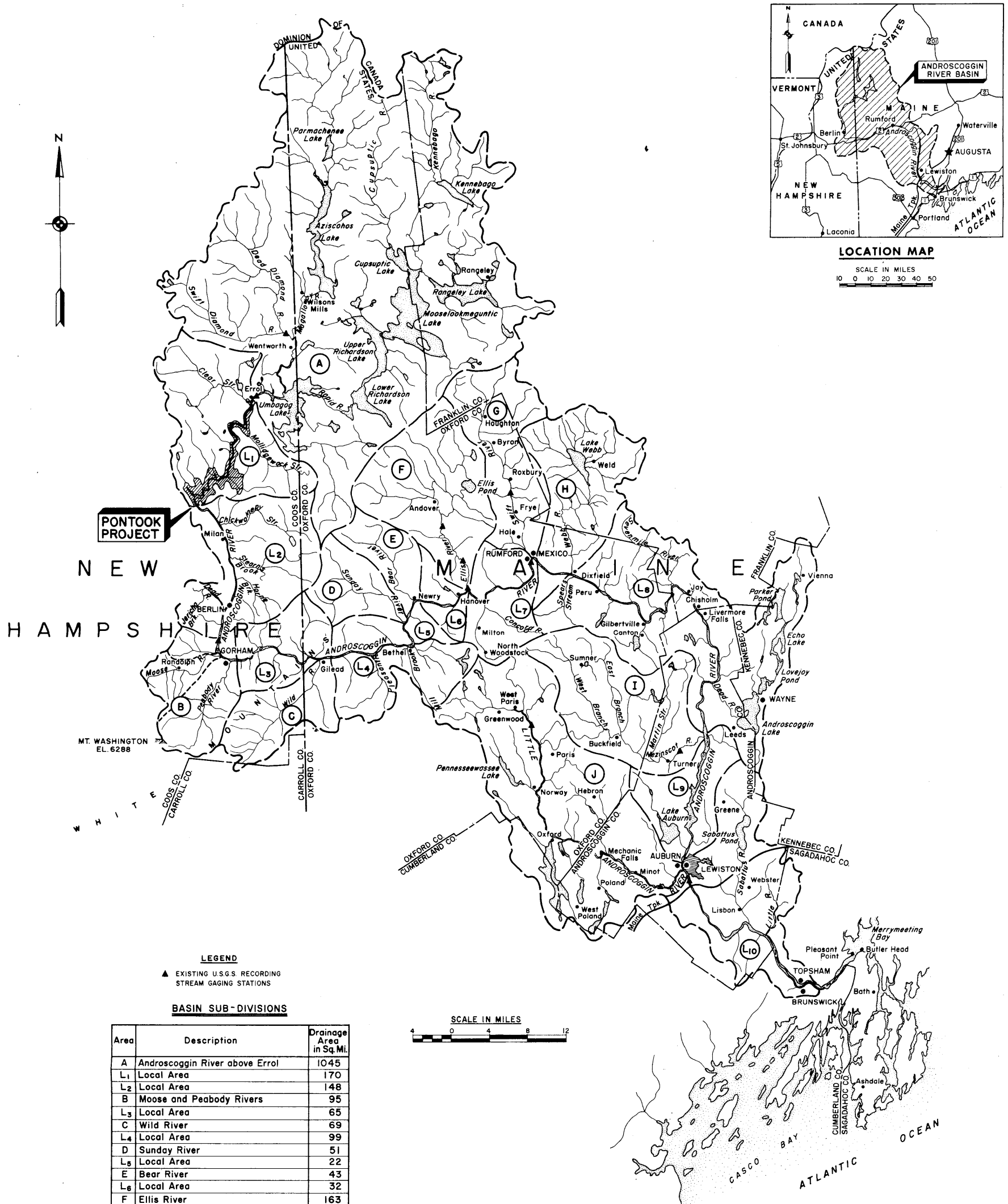
11. OTHER PROJECTS STUDIED

a. Ellis Dam and Reservoir. The Ellis dam site is located in the town of Rumford, Maine on the Ellis River approximately one mile above its confluence with the Androscoggin River. The project was studied for flood control alone and for flood control in combination with recreation and hydroelectric power. The reservoir impounded by the dam would have a flood control storage of 70,000 acre-feet equivalent to eight inches of runoff from a drainage area of 164 square miles.

The unit hydrograph analysis developed for the Swift River was assumed to be applicable to the ungaged Ellis River. From observations of local residents, and further analysis of the extensive natural storage characteristics of the lower Ellis River, it is now considered the flood records for the Swift River gage are not applicable for the Ellis River at its mouth. Field observations indicate that rapid rises on the Androscoggin River cause water to flow upstream at the mouth of the Ellis River into the storage area. This unusual characteristic tends to both reduce the flow on the Androscoggin River and temporarily delay all discharge from the Ellis River. This reduction effect occurs principally while the stages are rising on the main river, diminishes as the main river crests, and adds to the flow while the flood stages are receding.

At this time there is insufficient information available to adequately analyze this phenomenon. Various assumptions have been made in studying the effect of the valley storage, but there are too many variables and unknowns to have confidence in the results. To obtain basic data, the U. S. Geological Survey installed three temporary gaging stations on the lower Ellis River for about a two-year period, during which time, two minor rises occurred, both of which lacked sufficient hydraulic data for a thorough evaluation. One of these gages, located on the Ellis River at South Andover, Me. with a drainage area of 131 square miles is still being maintained by the U.S.G.S.

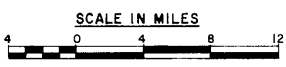
b. Hale and Roxbury Projects. Two flood control reservoir sites were studied on the Swift River because of its high contribution to flood flows. However, because of the high construction costs of the dams, neither the Hale site, draining 111 square miles, nor the Roxbury site, draining 80 square miles, was economically feasible. Both sites were investigated for flood control alone; the Hale site was also investigated for flood control in combination with power and recreation. Flood control storage requirements were equivalent to approximately eight inches of runoff. Unit hydrographs for determining spillway design floods were based on unit hydrograph studies for the Swift River at the USGS gage at Roxbury, drainage area 95.8 square miles.



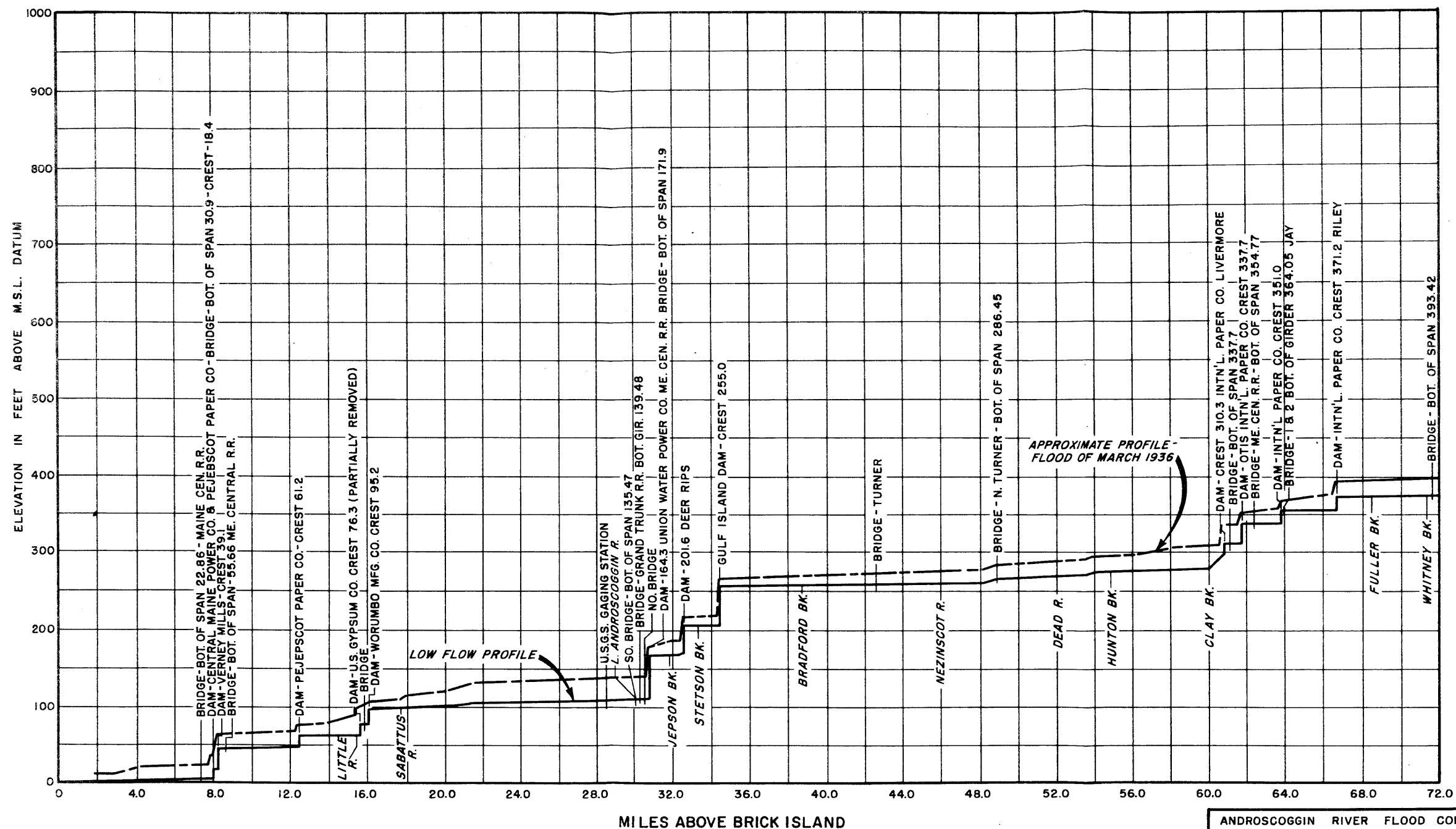
LEGEND
▲ EXISTING U.S.S. RECORDING
STREAM GAGING STATIONS

BASIN SUB-DIVISIONS

Area	Description	Drainage Area in Sq. Mi.
A	Androscoggin River above Errol	1045
L1	Local Area	170
L2	Local Area	148
B	Moose and Peabody Rivers	95
L3	Local Area	65
C	Wild River	69
L4	Local Area	99
D	Sunday River	51
L5	Local Area	22
E	Bear River	43
L6	Local Area	32
F	Ellis River	163
L7	Local Area	65
G	Swift River	125
H	Swift River plus Local Area	145
L8	Local Area	323
I	Nezinscot River	181
L9	Local Area	63
J	Little Androscoggin River	353
L10	Local Area	173
	Androscoggin River above Brunswick	3430



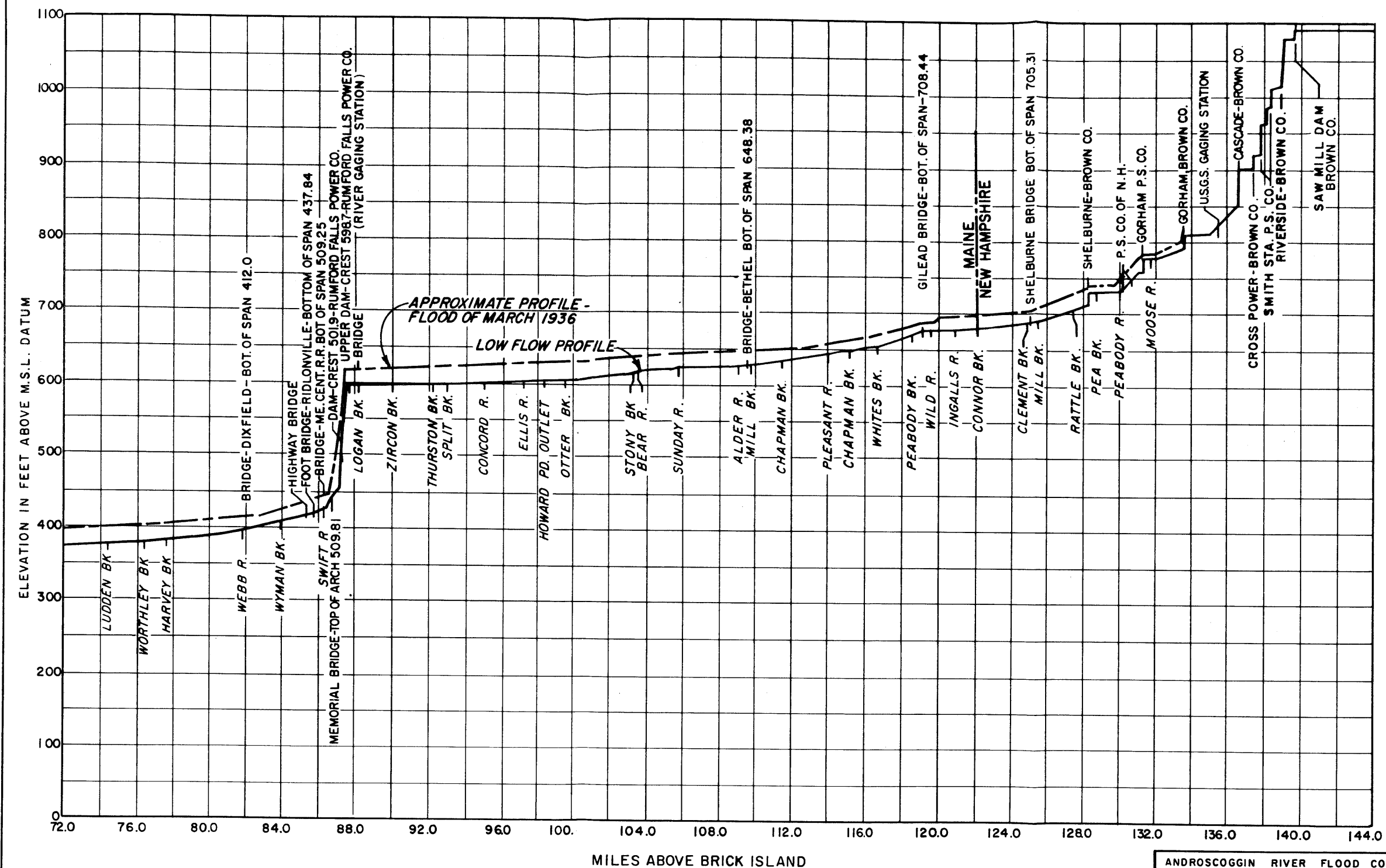
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BASIN MAP				
ANDROSCOGGIN RIVER, MAINE & N.H.				
APPROVED		DATE		
CHIEF, PLANN. & RPTS. BRANCH		CHIEF ENGINEERING DIV.		
SCALE AS SHOWN		DRAWING NUMBER		
SHEET 1 OF 1				



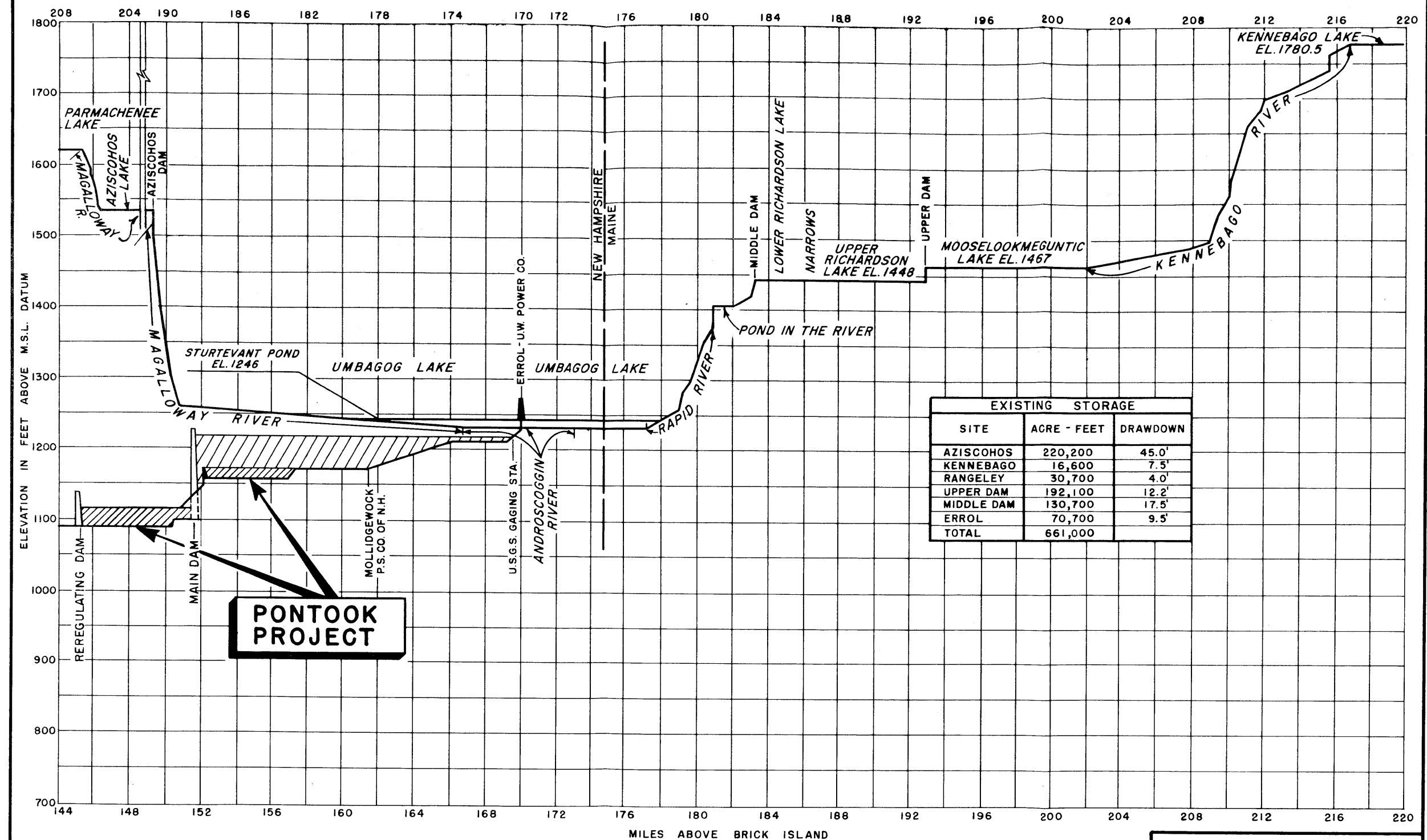
ANDROSCOGGIN RIVER FLOOD CONTROL
**ANDROSCOGGIN RIVER
 PROFILE**
 ANDROSCOGGIN RIVER MAINE & N.H.
 U.S. ARMY ENGINEER DIVISION
 NEW ENGLAND
 WALTHAM, MASS.

ARMY N.E.D. BOSTON OCTOBER 7, 1952

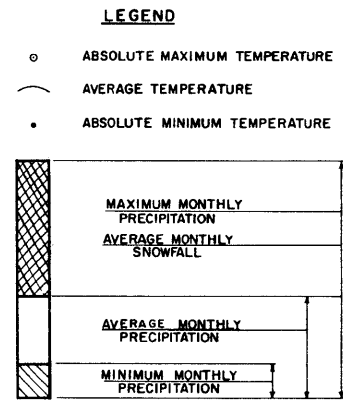
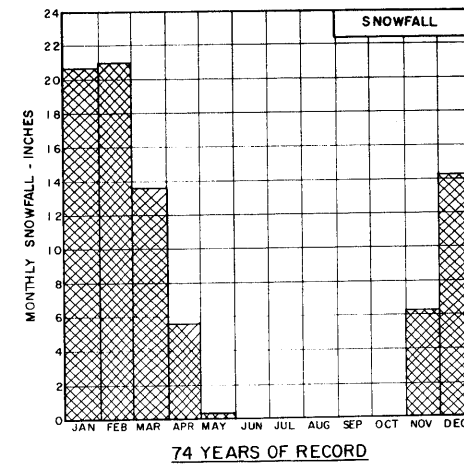
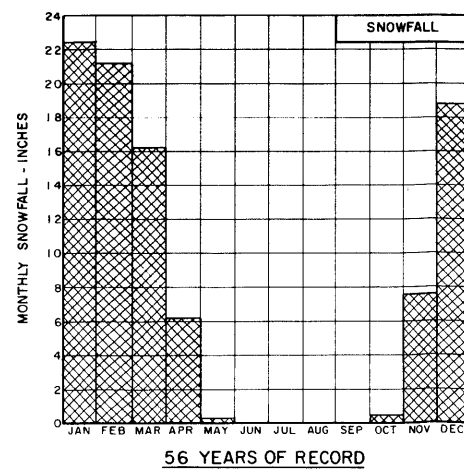
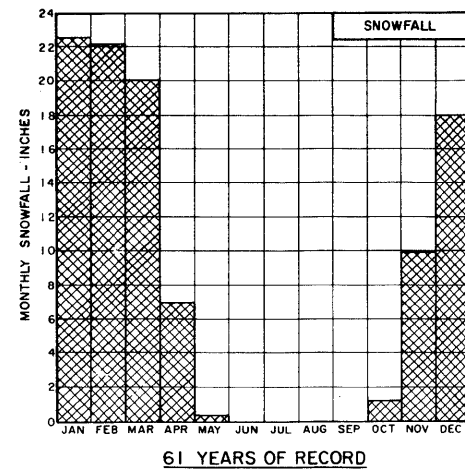
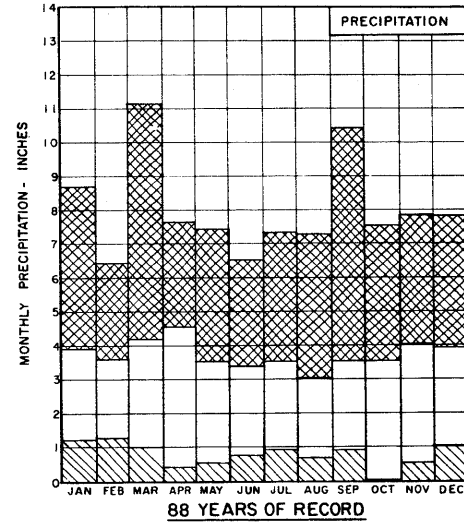
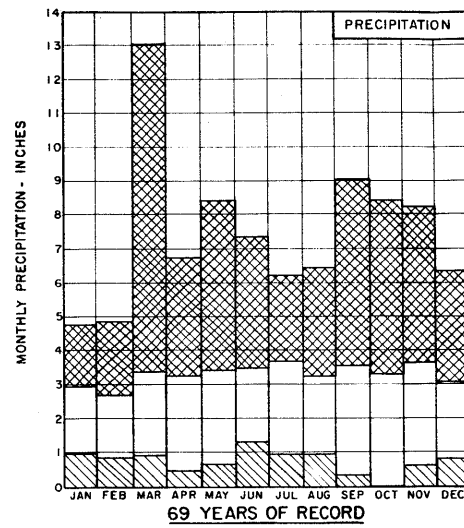
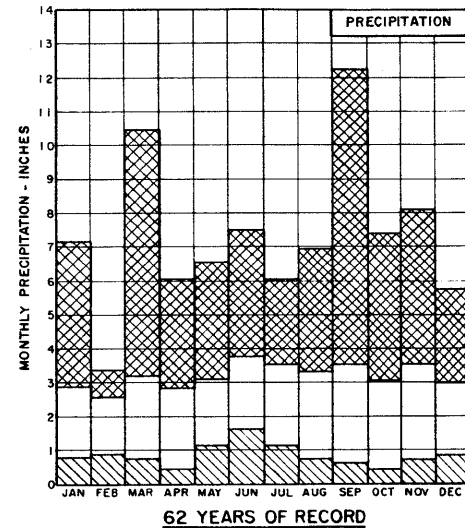
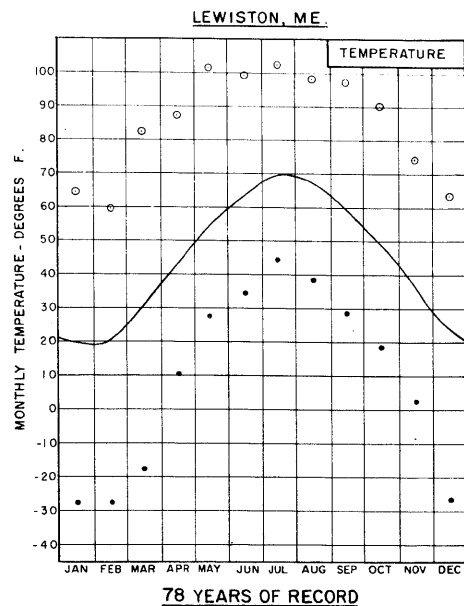
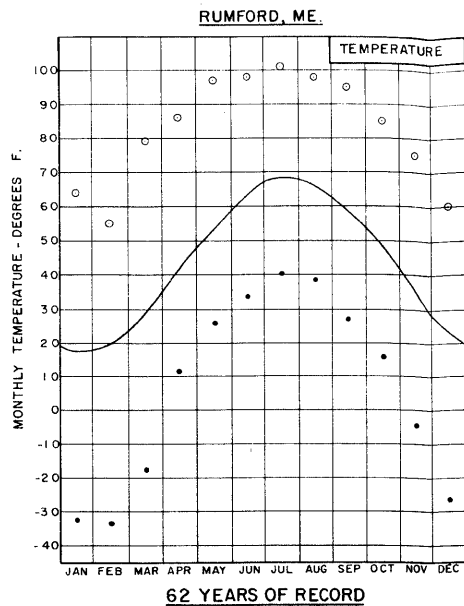
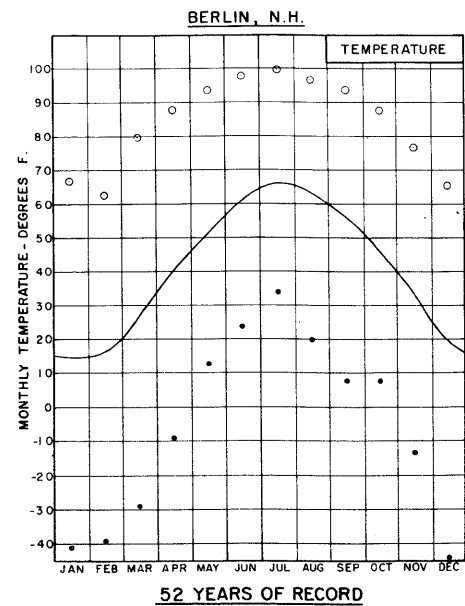
PLATE NO. B-2



ANDROSCOGGIN RIVER FLOOD CONTROL
**ANDROSCOGGIN RIVER
 PROFILE**
 ANDROSCOGGIN RIVER MAINE & N.H.
 U.S. ARMY ENGINEER DIVISION
 NEW ENGLAND
 WALTHAM, MASS.



ANDROSCOGGIN RIVER FLOOD CONTROL
**ANDROSCOGGIN RIVER
 PROFILE**
 ANDROSCOGGIN RIVER MAINE & N.H.
 U.S. ARMY ENGINEER DIVISION
 NEW ENGLAND
 WALTHAM, MASS.



REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY: TR. BY: CK. BY: ANDROSCOGGIN RIVER FLOOD CONTROL

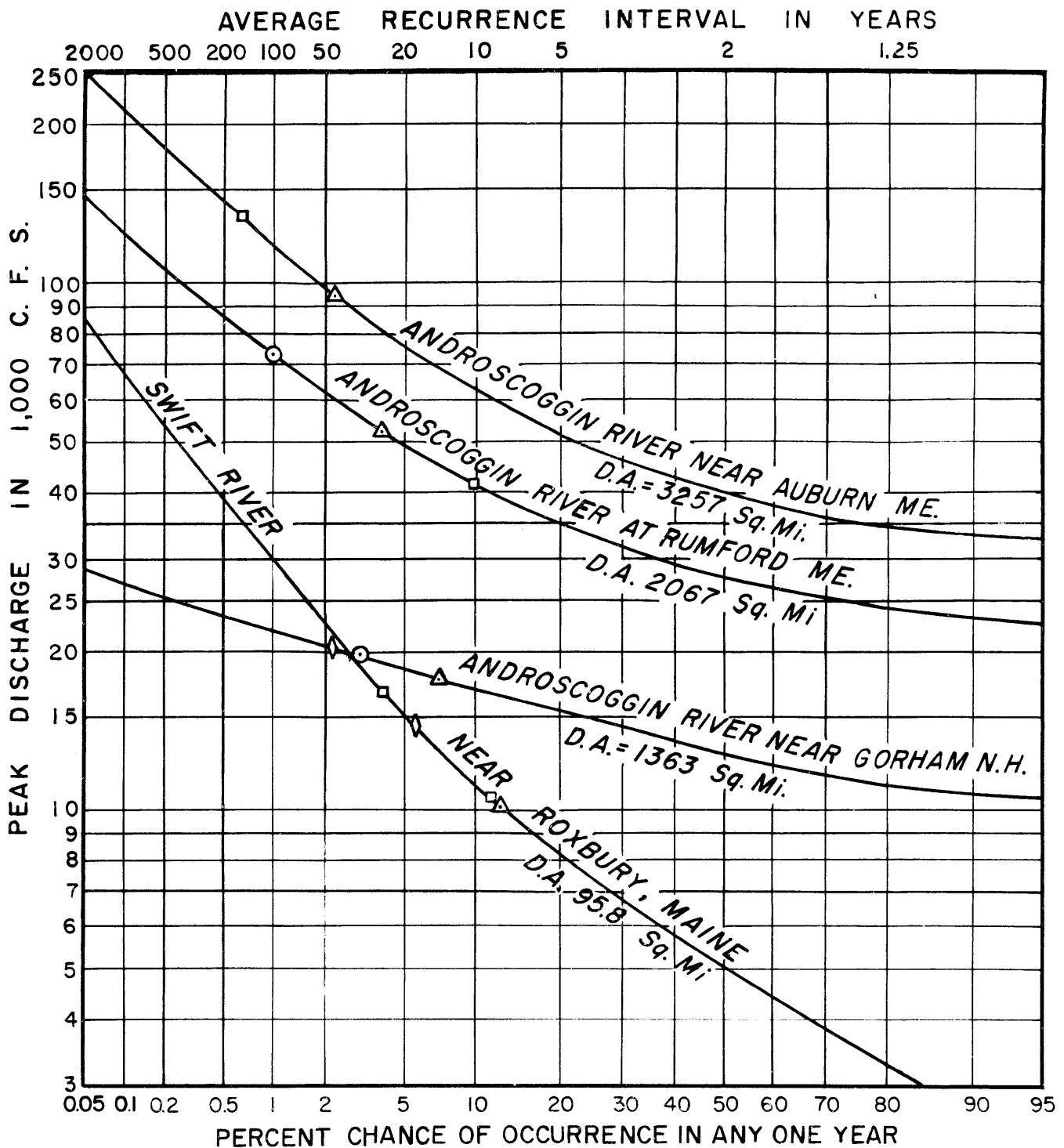
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CHEF. SUBMITTED BY: ANDROSCOGGIN RIVER, MAINE & N.H. DATE:

CHEF. PLANS & RPTS. BRANCH: APPROVED: CHIEF ENGINEERING DIV.

SCALE: SPEC. NO. CIV. ENG. - 19-016- DRAWING NUMBER:

SHEET:



- MARCH 1936 FLOOD
- △ MARCH 1953 FLOOD
- OCTOBER 1959 FLOOD
- ◇ OTHER FLOODS OF RECORD

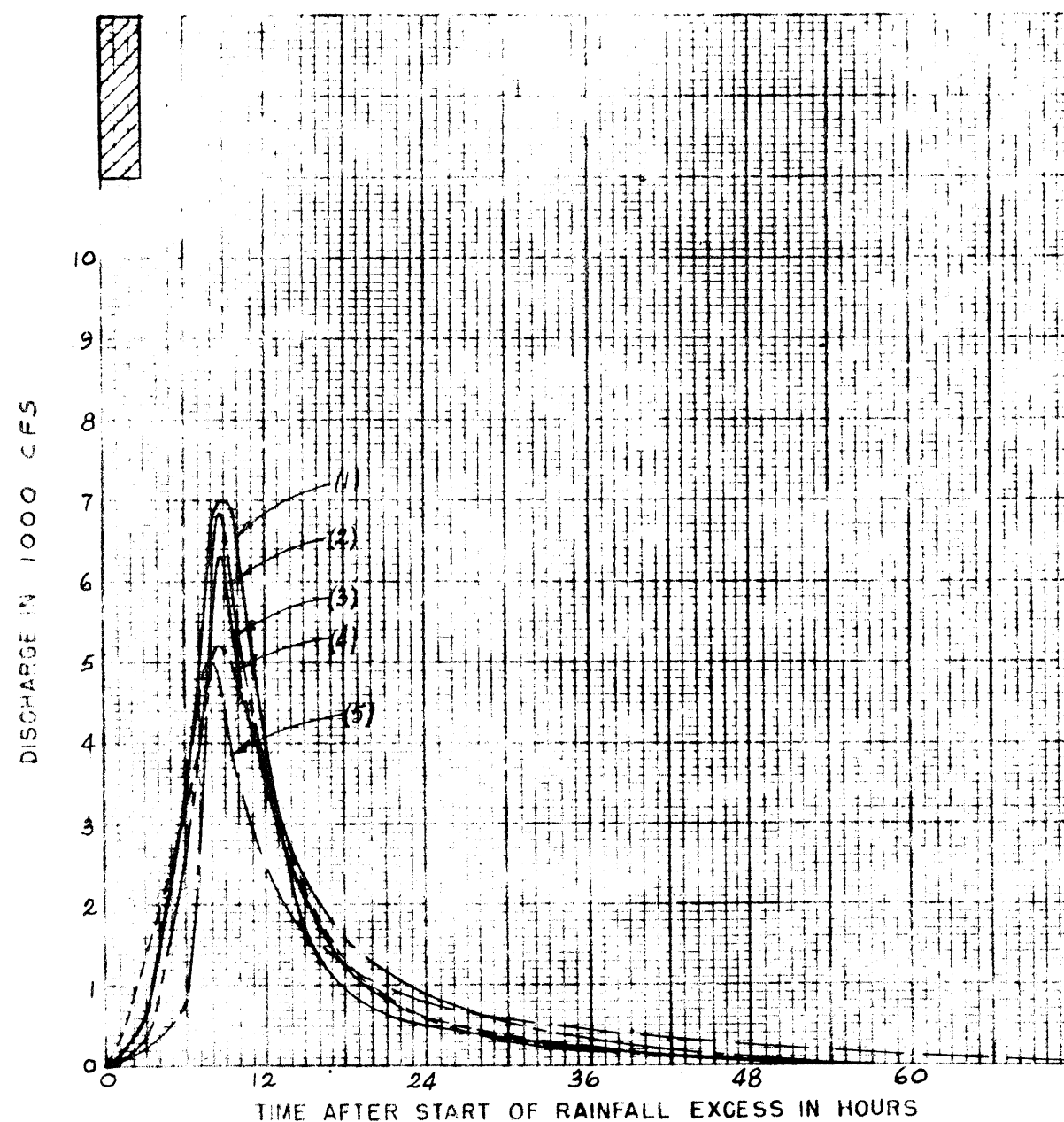
ANDROSCOGGIN RIVER DRAINAGE
AREAS INCLUDE 1045 SQ. MI. ABOVE
ERROL.

ANDROSCOGGIN RIVER FLOOD CONTROL

PEAK DISCHARGE FREQUENCY CURVES

ANDROSCOGGIN RIVER MAINE & N.H.
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS

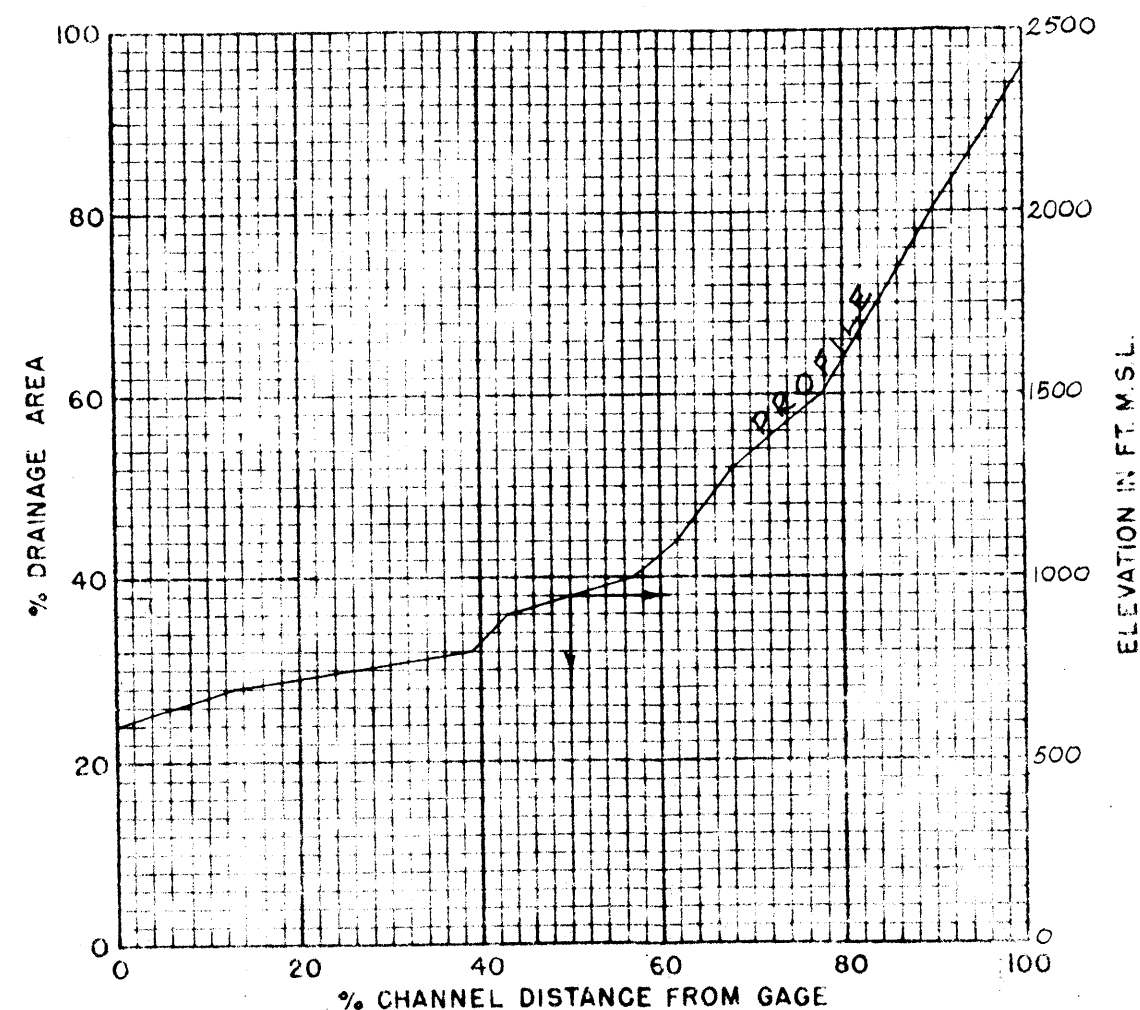
OBSERVED UNIT HYDROGRAPHS



DRAINAGE AREA CHARACTERISTICS

DRAINAGE AREA	95.8 sq. mi.	L	19 mi.
MAXIMUM ELEVATION	2400 ft. m.s.l.	L_{co}	10.8 mi.
MINIMUM ELEVATION	600 ft. m.s.l.	$(LL_{co})^{0.8}$	4.94
MEAN ELEVATION (weighted)	— ft. m.s.l.	DRAINAGE DENSITY	— mi./sq. mi.
LAND SLOPE	— ft./mi.	MAP SCALE	1:62500
MAIN STREAM SLOPE	64.8 ft./mi.	METHOD OF FLOW SEPARATION	TYPE A
		BASIN SHAPE FACTOR	3.77

ELEVATION IN FT. M.S.L.



DATA FROM OBSERVED UNIT HYDROGRAPHS

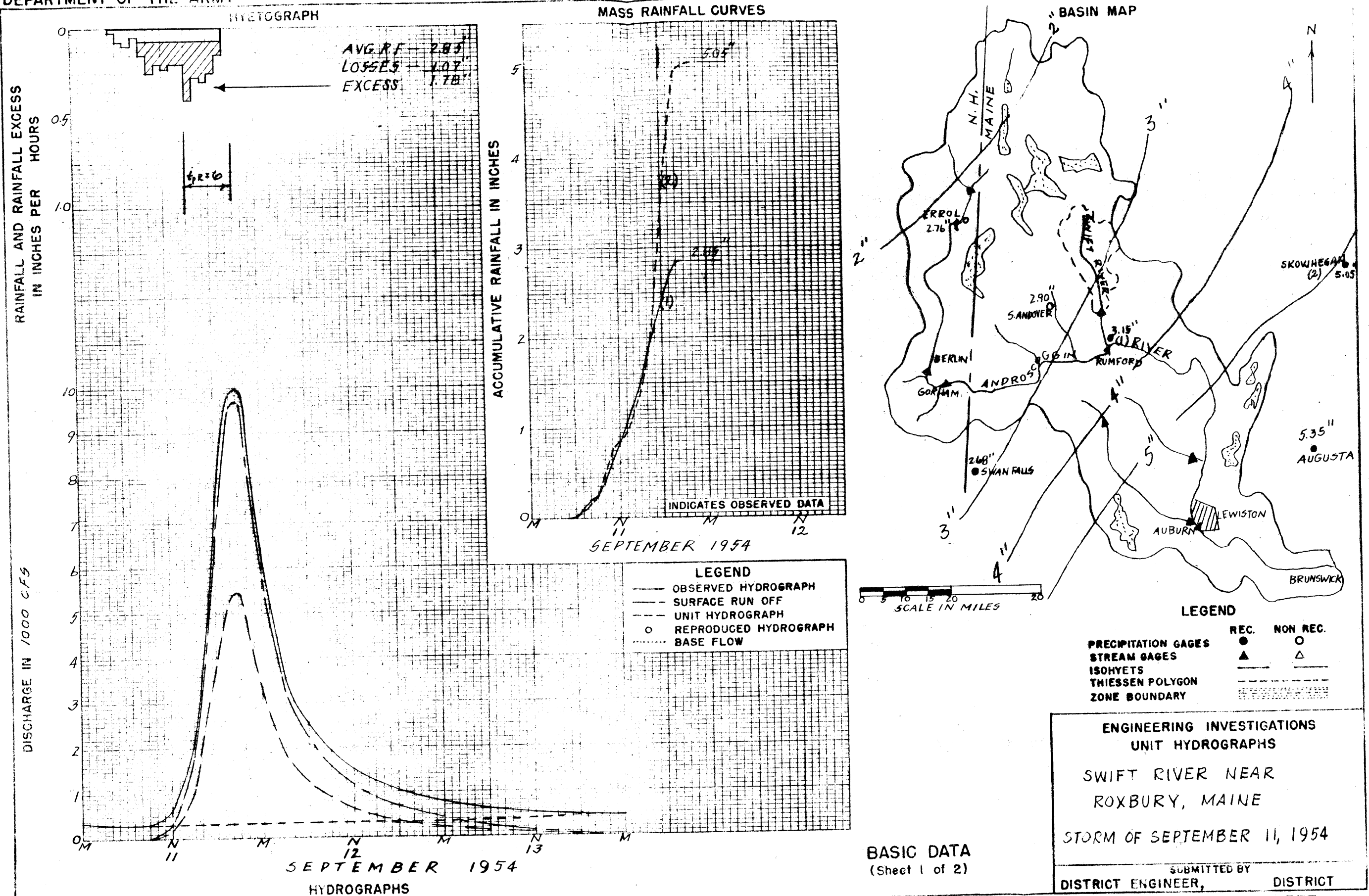
DATE OF RAINFALL	LEGEND	AVE P (in.)	RAINFALL EXCESS DURATION (hr.)	AMOUNT (in.)	L_{cp} (mi.)	STAGE RECORD	Q_{pR} (cfs)	Q_{pR} in 3 hrs (cfs)	t_{pR} (hr.)	t_p (hr.)	t_v (hr.)	C_{IR}	C_{p640}	K_m (hr.)	T_c (hr.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
SEPT. 11, 1954	(1) —	2.85	12	1.78	Unifor.	Rec.	5,430	7,000	6.0	7.5		1.52	550		
JUNE 15, 1943	(2) —	2.00	3	1.49	Unifor.	Rec.	6,850	6,850	7.0	7.0		1.42	500		
OCT. 23-24, 1959	(3) —	4.50	12	2.80	Unifor.	Rec.	5,100	6,300	7.5	8.0		1.62	526		
JUNE 14-15, 1942	(4) —	4.94	6	3.08	Unifor.	Rec.	4,800	5,200	8.0	7.0		1.42	380		
NOV. 25-26, 1950	(5) —	3.54	6	2.78	Unifor.	Rec.	4,100	5,000	7.0	6.5		1.32	339		

ENGINEERING INVESTIGATIONS
UNIT HYDROGRAPHSSWIFT RIVER NEAR
ROXBURY, MAINE

PERTINENT DATA

SUBMITTED BY
DISTRICT ENGINEER, DISTRICT

Plate No. B-7 SHEET



UNIT HYDROGRAPH BASIC DATA SHEET

(7) STREAM AND STATION Swift River near Roxbury, Maine LAT. 44° 38' 30" LONG. 70° 35' 15"

(8) DATE OF STORM September 11, 1954 (9) OFFICE New England Division

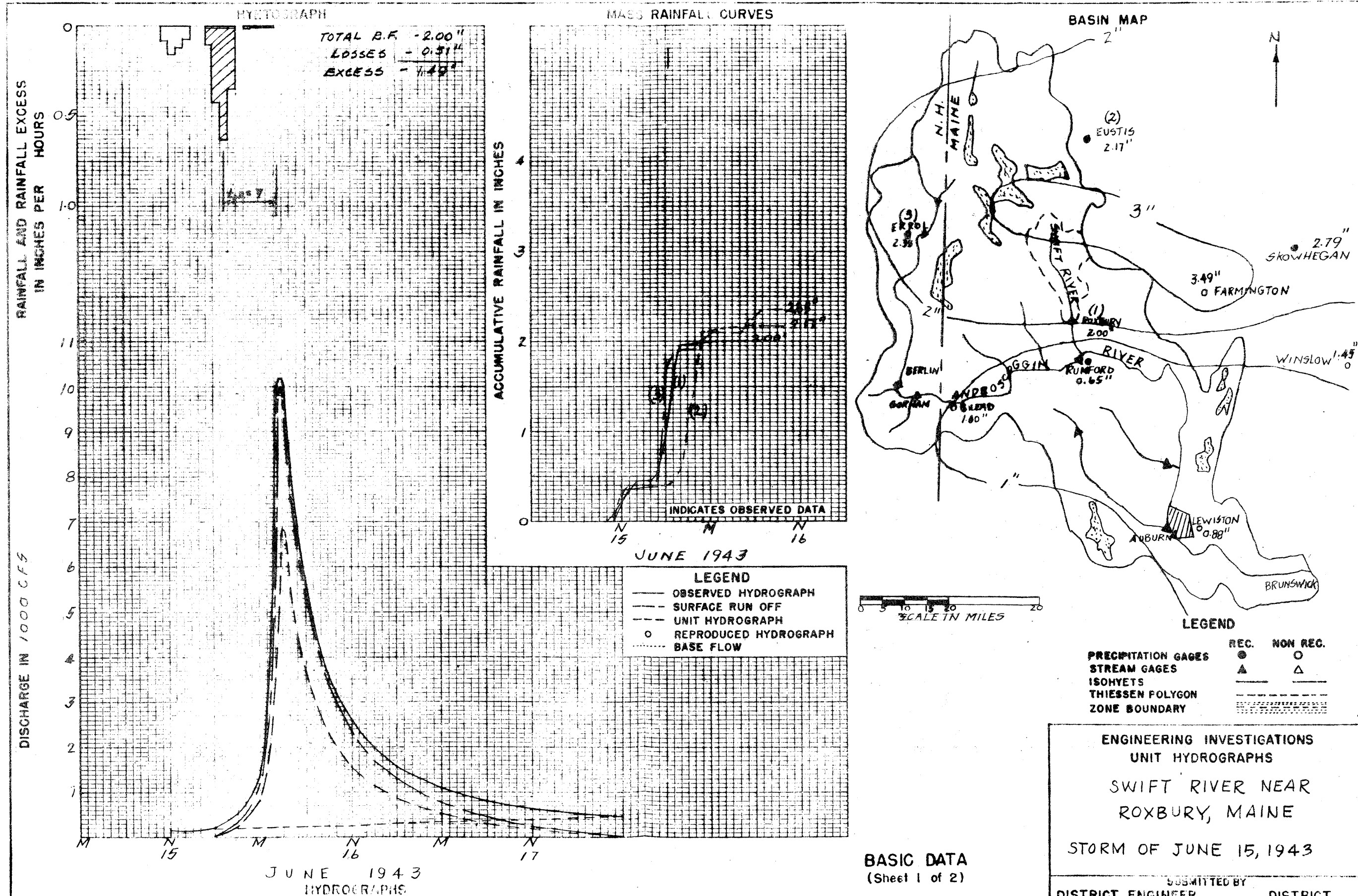
(10) DRAINAGE AREA 95.8 SQ. MI. (11) L 19 MI. (12) L_{ca} 10.8 MI. (13) $(L_{ca})^{0.3}$ 4.94

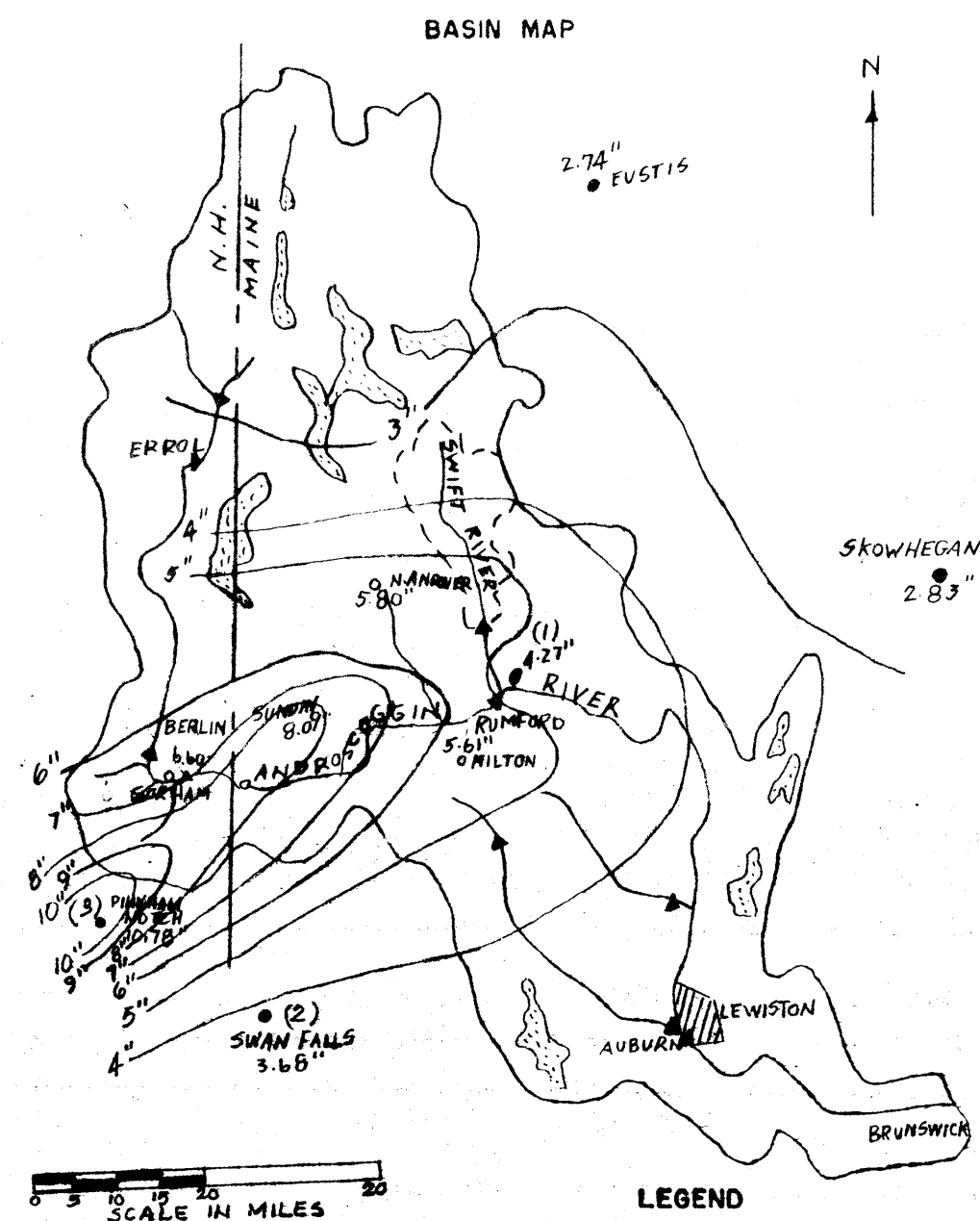
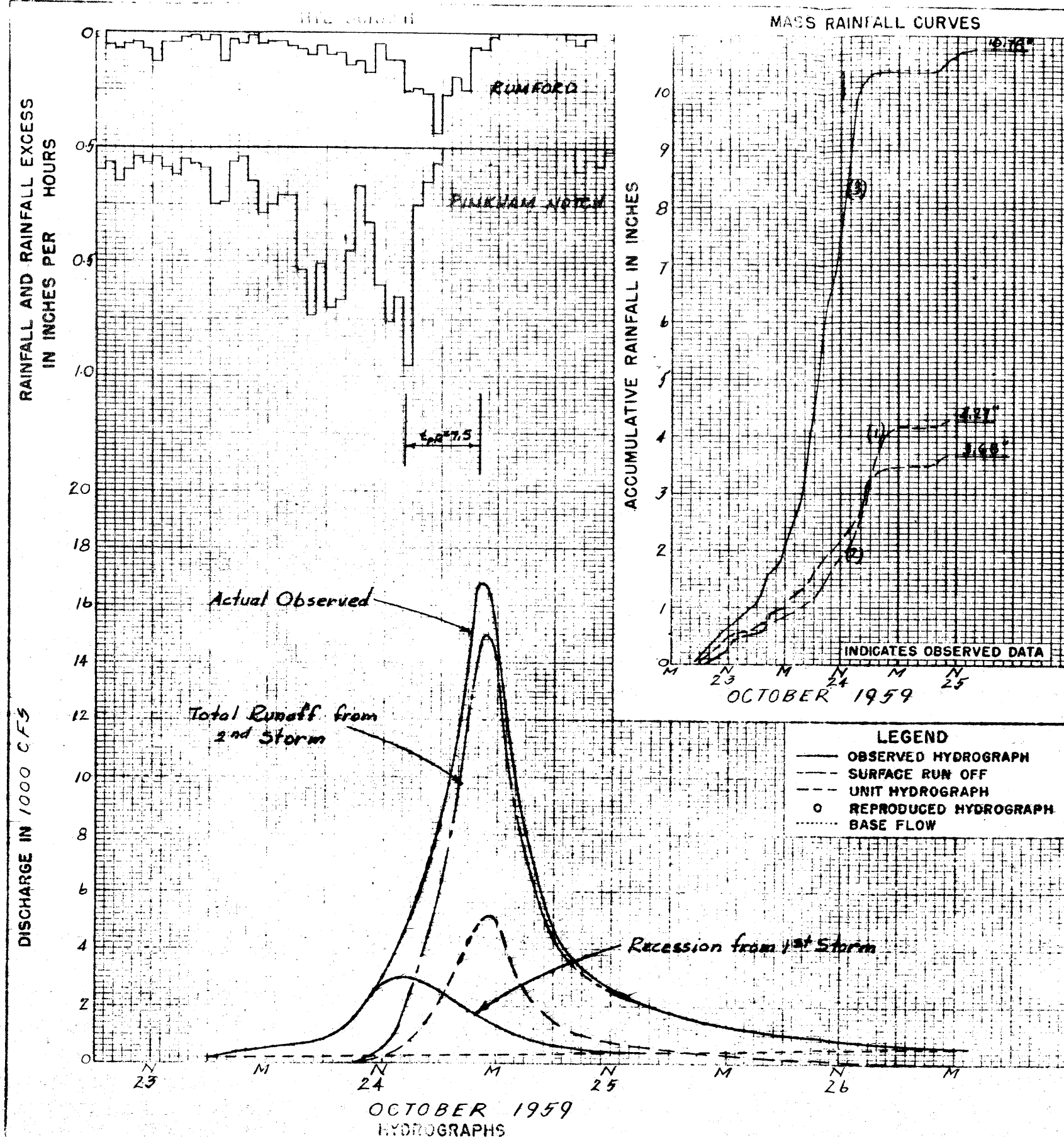
(14) AVERAGE RAINFALL 2.85 IN. (15) t_R 12 HRS. (16) DIRECT RUNOFF 1.78 IN.

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(21) t_p 7.5 HRS. (22) t_v _____ HRS. (23) C_{tr} 1.52 (24) C_p^{640} 550 W_{50} 6.5 HRS. W_{75} 4 HRS.

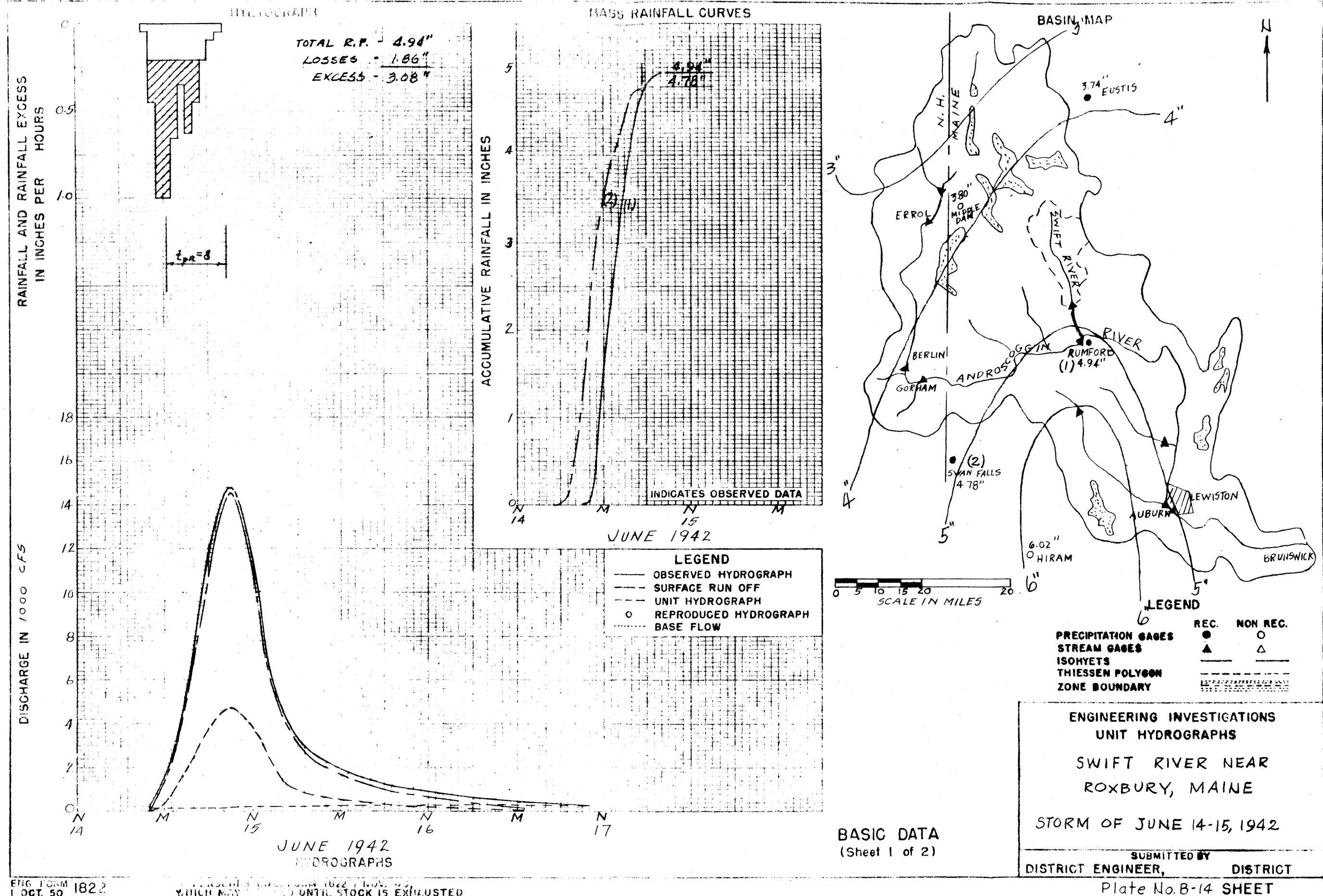
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BASIC DATA
(Sheet 1 of 2)

ENGINEERING INVESTIGATIONS
UNIT HYDROGRAPHS
SWIFT RIVER NEAR
ROXBURY, MAINE
STORM OF OCTOBER 23-24, 1959
SUBMITTED BY
DISTRICT ENGINEER, DISTRICT
Plate No. B-12 SHEET



UNIT HYDROGRAPH BASIC DATA SHEET

(7) STREAM AND STATION Swift River near Roxbury, Maine LAT. 44°38'30" LONG. 70°35'15"

(8) DATE OF STORM June 14-15, 1942 (9) OFFICE New England Division

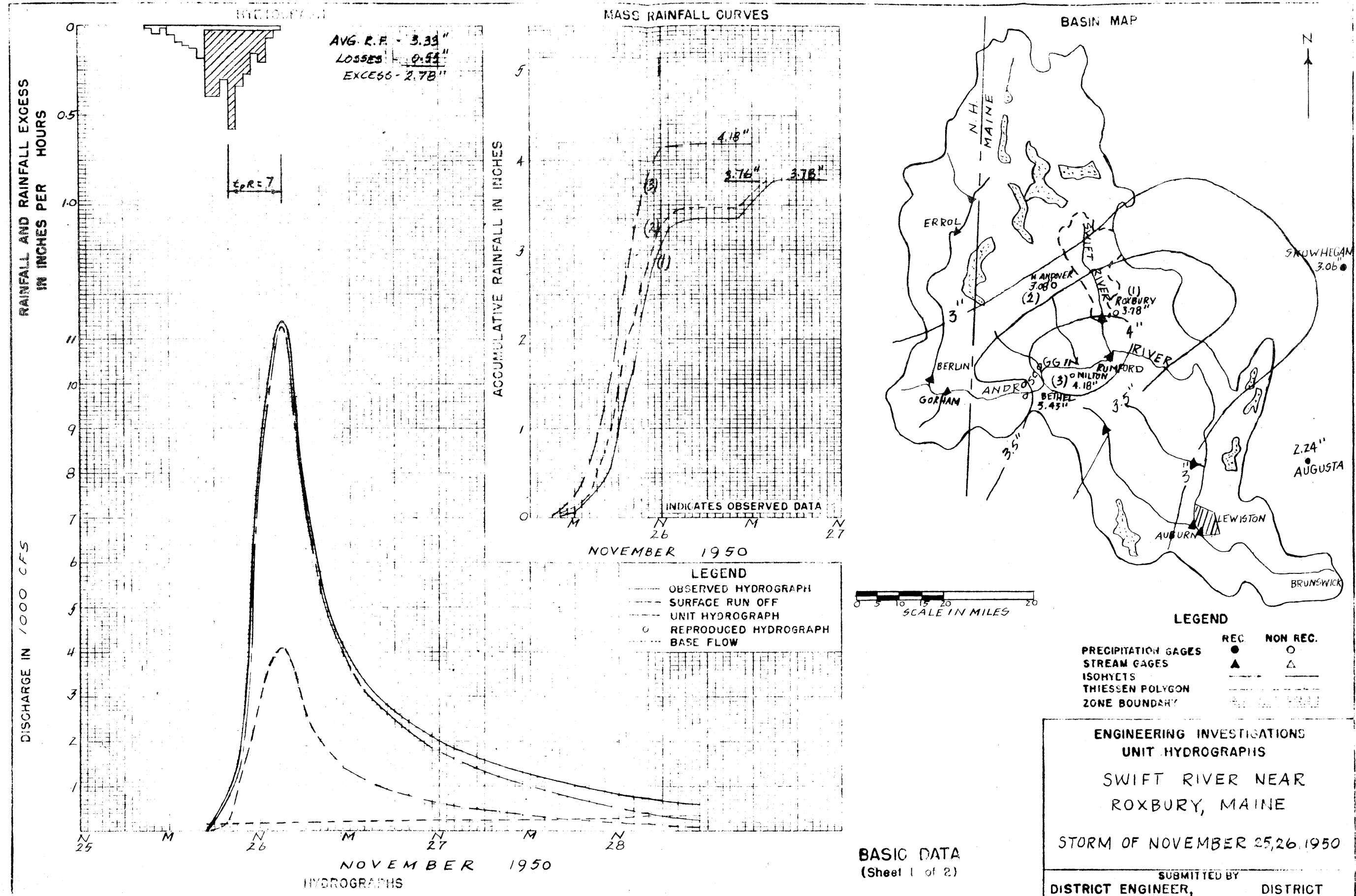
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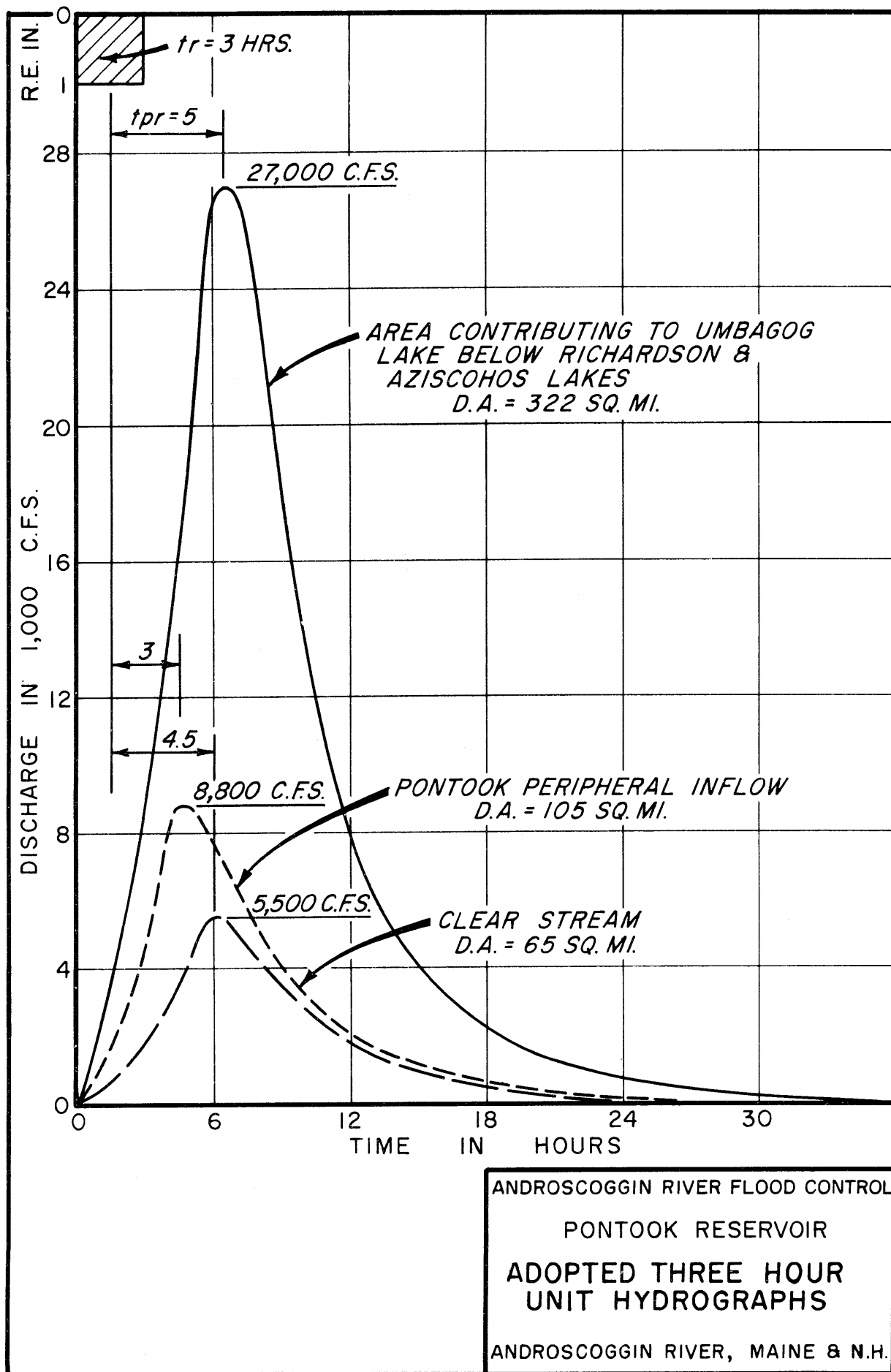
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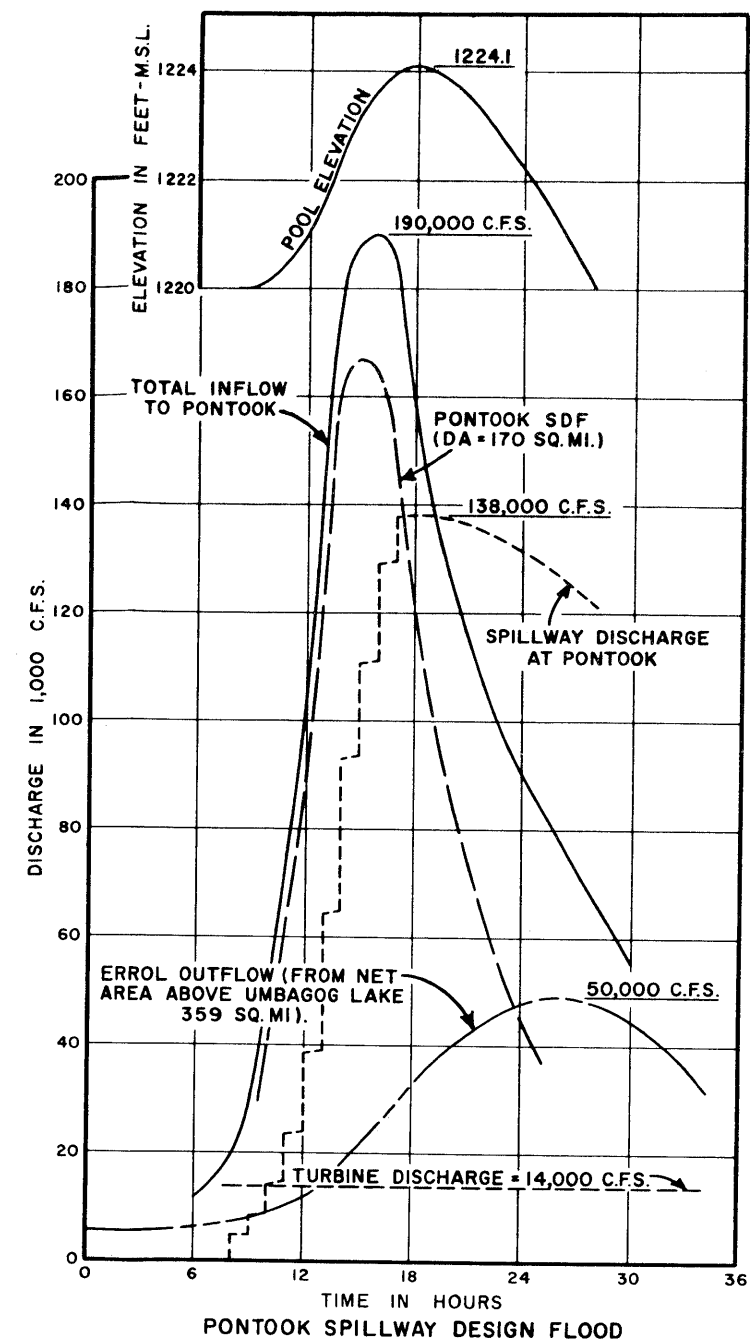
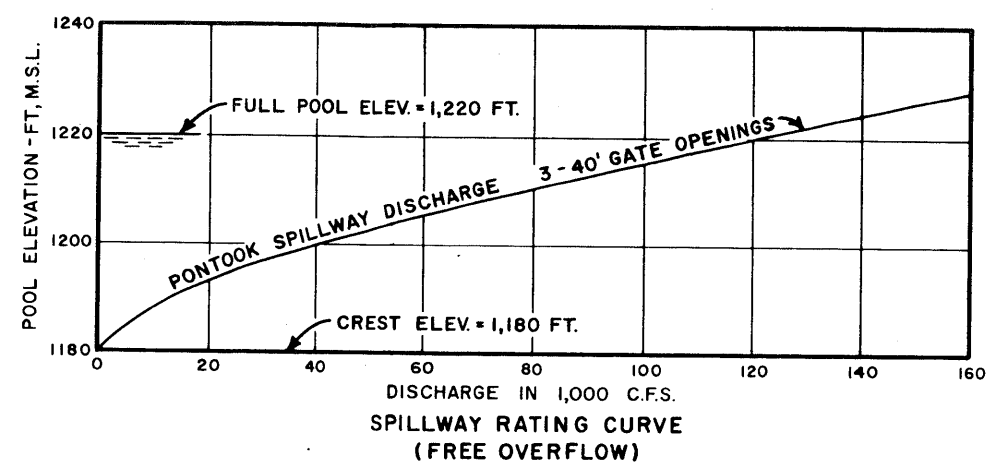
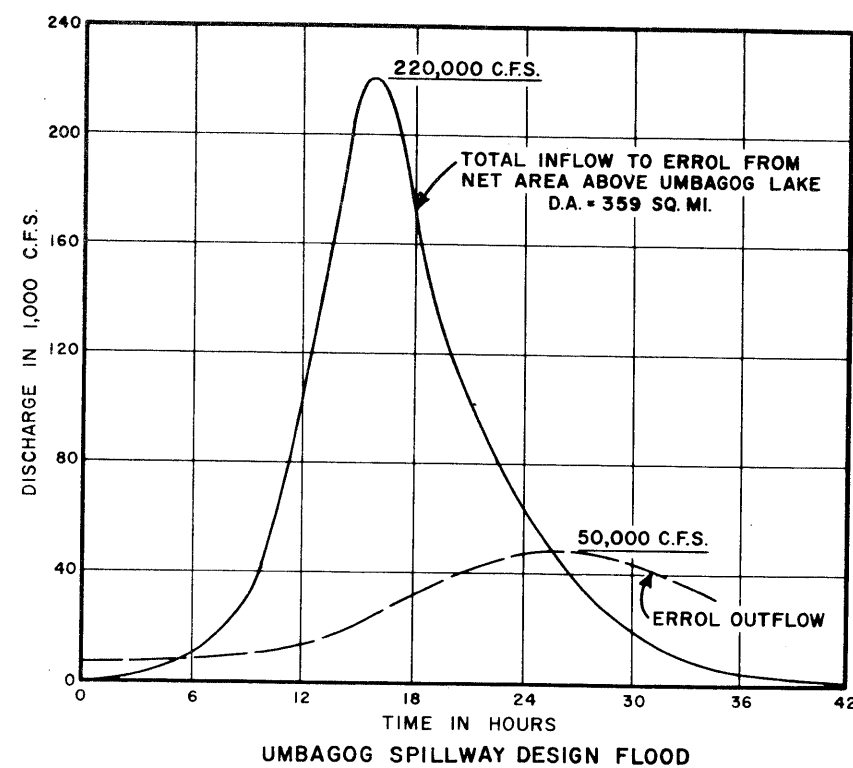
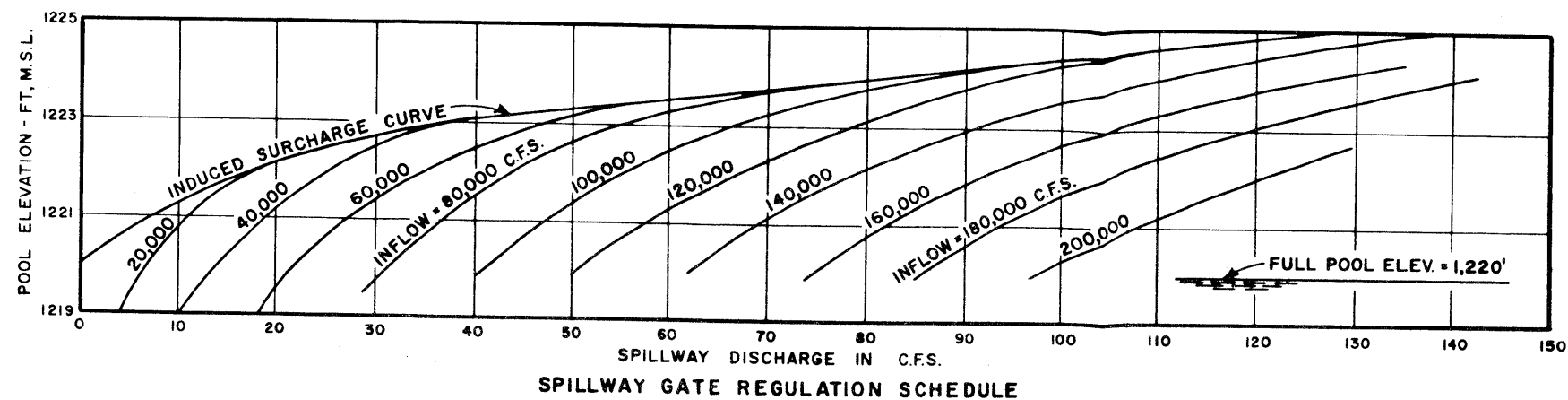
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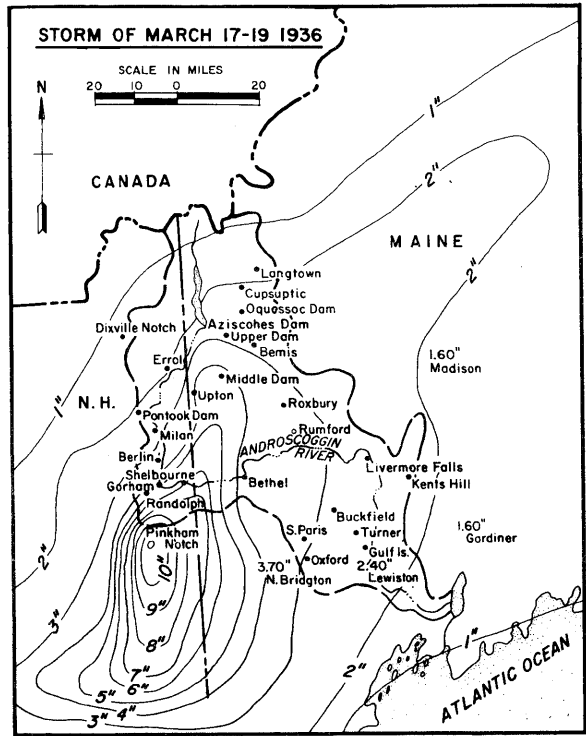
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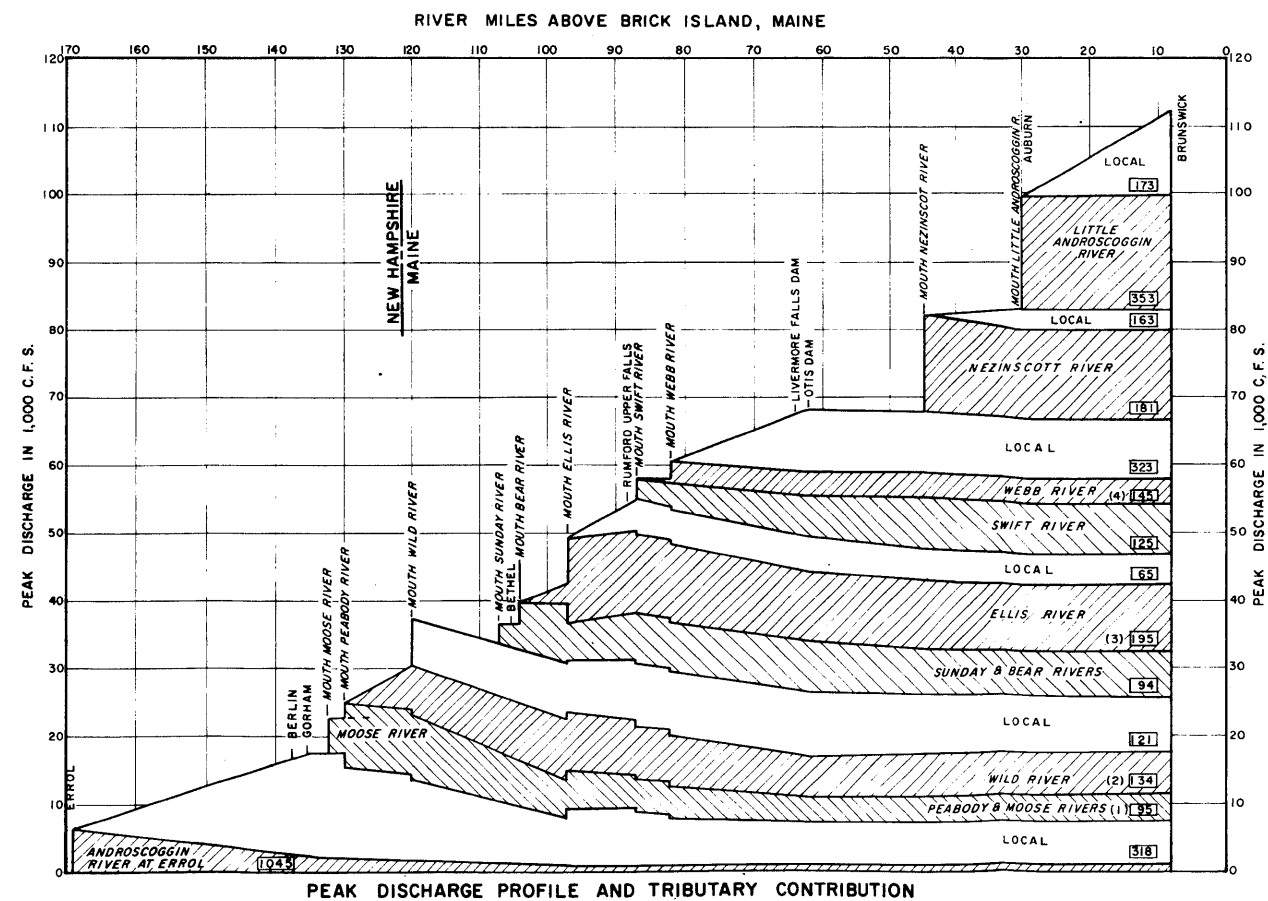
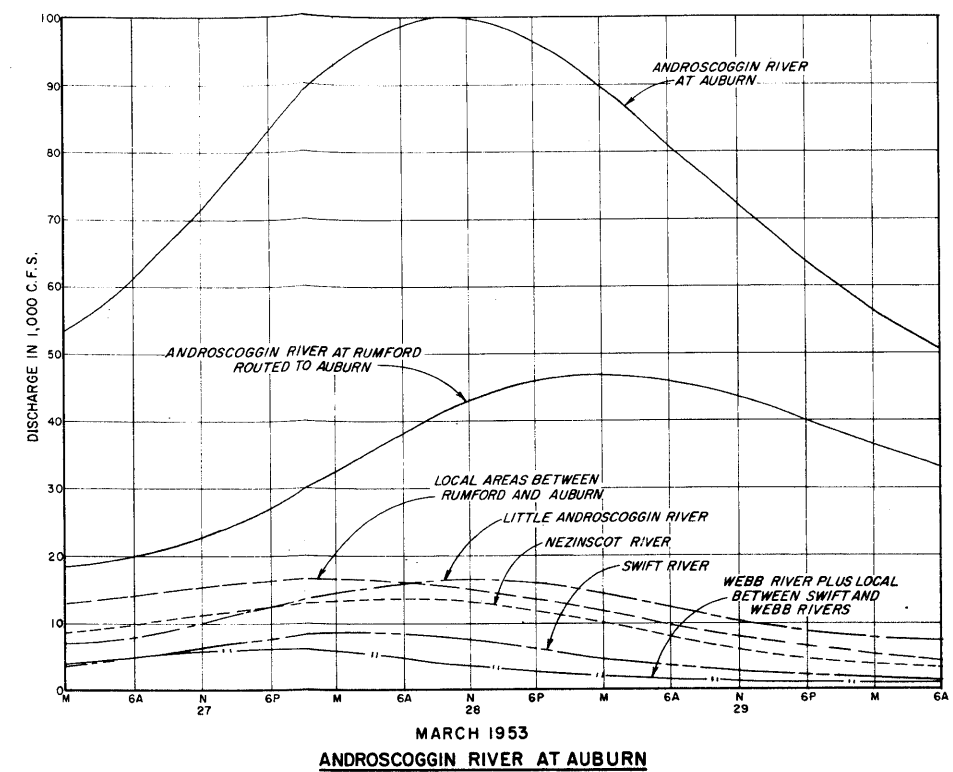
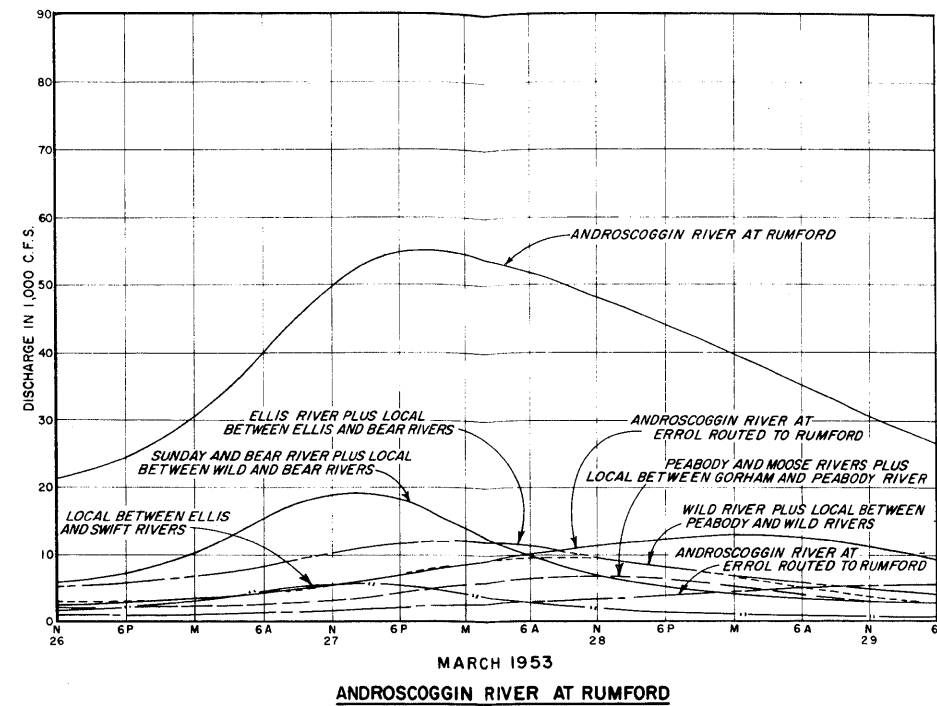
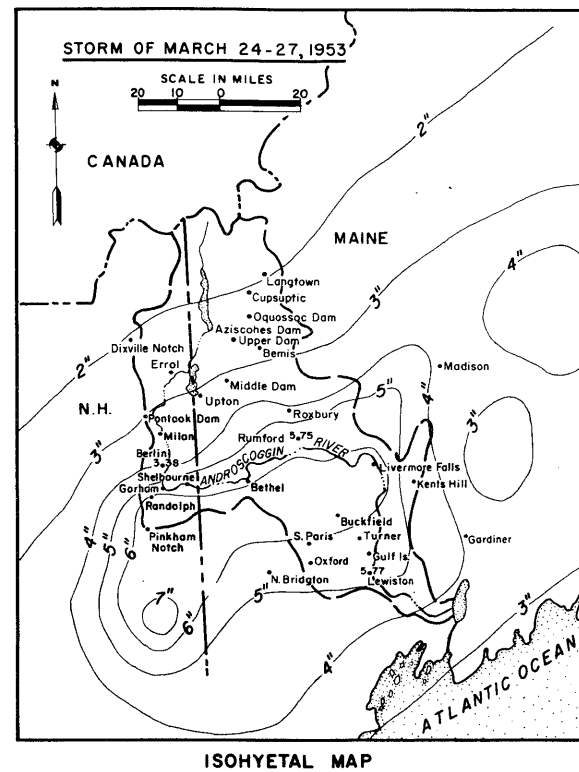






ANDROSCOGGIN RIVER FLOOD CONTROL
PONTOK RESERVOIR
SPILLWAY DESIGN FLOOD
ANDROSCOGGIN RIVER, MAINE & N.H.





LEGEND

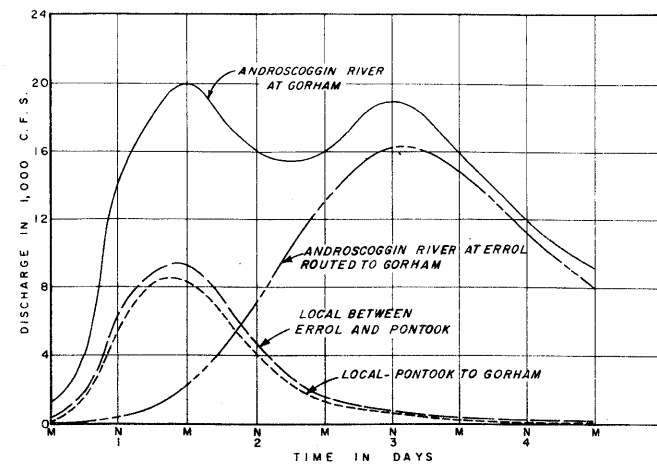
[1363] DRAINAGE AREA IN SQUARE MILES

NOTES:

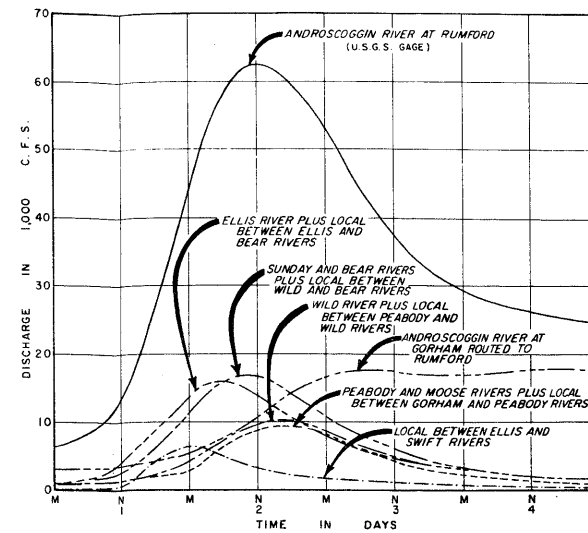
- (1) Includes 24 Square Miles of Local Area.
- (2) Includes 65 Square Miles of Local Area.
- (3) Includes 32 Square Miles of Local Area.
- (4) Includes 13 Square Miles of Local Area.

REVISION	DATE	DESCRIPTION	BY

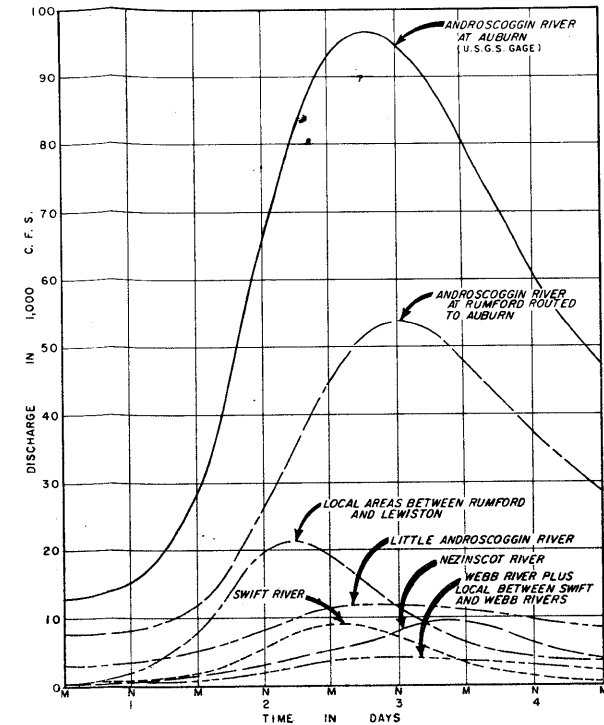
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.			
DR. BY	TR. BY	CK. BY	ANDROSCOGGIN RIVER FLOOD CONTROL FLOOD OF MARCH 1953
PROJECT ENGINEER			ANDROSCOGGIN RIVER, MAINE & N.H.
SUBMITTED BY			
CHIEF, PLANS & RPT'S BRANCH	APPROVED	DATE	
CHIEF ENGINEERING DIV.	SCALE	SPEC. NO. CIV. ENG. - 18-016	DRAWING NUMBER



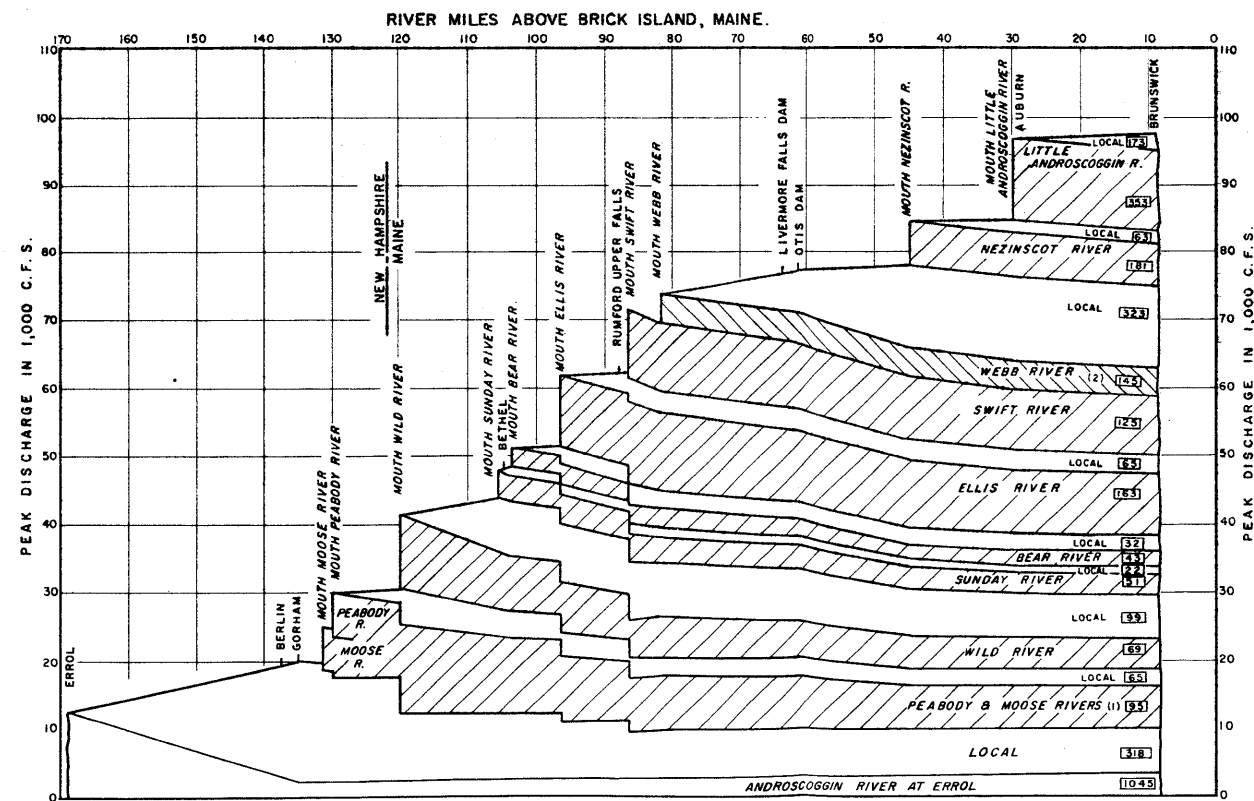
ANDROSCOGGIN RIVER AT GORHAM



ANDROSCOGGIN RIVER AT RUMFORD



ANDROSCOGGIN RIVER AT AUBURN



PEAK DISCHARGE PROFILE & TRIBUTARY CONTRIBUTIONS

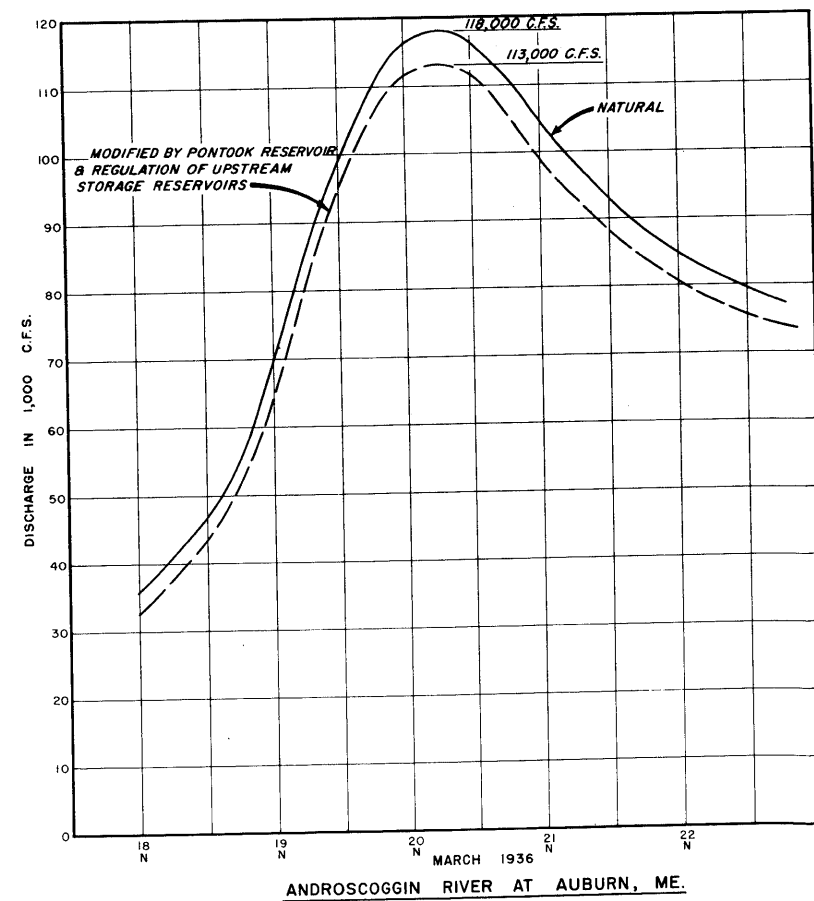
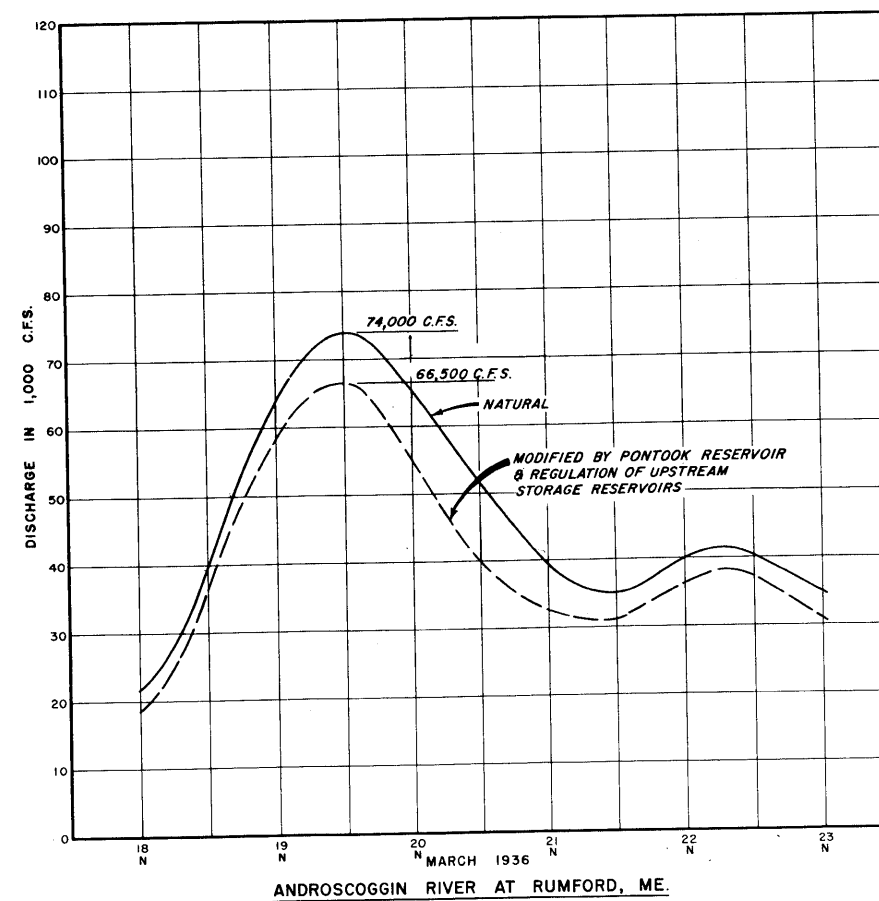
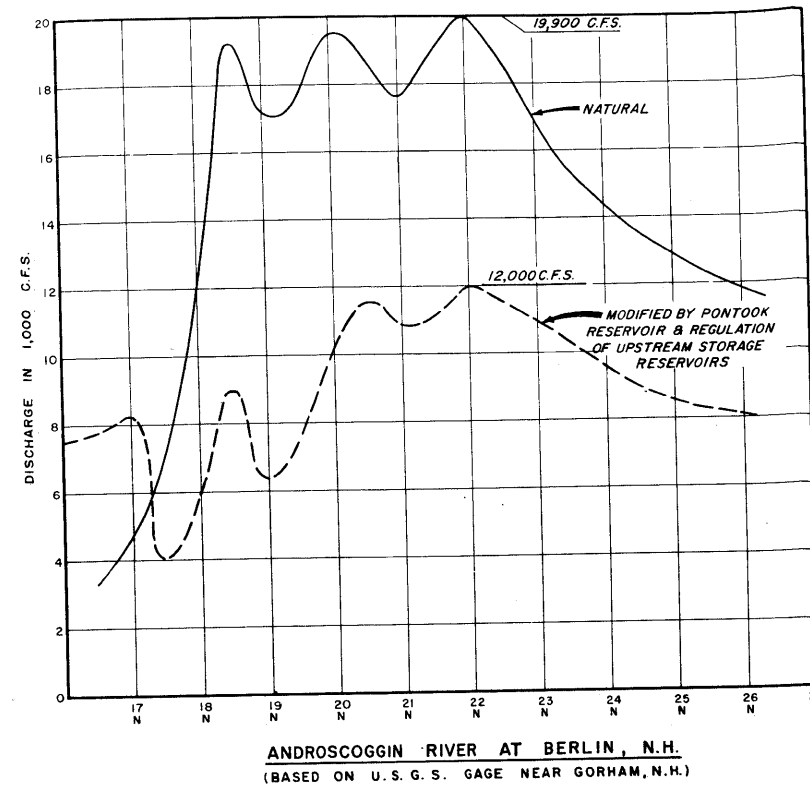
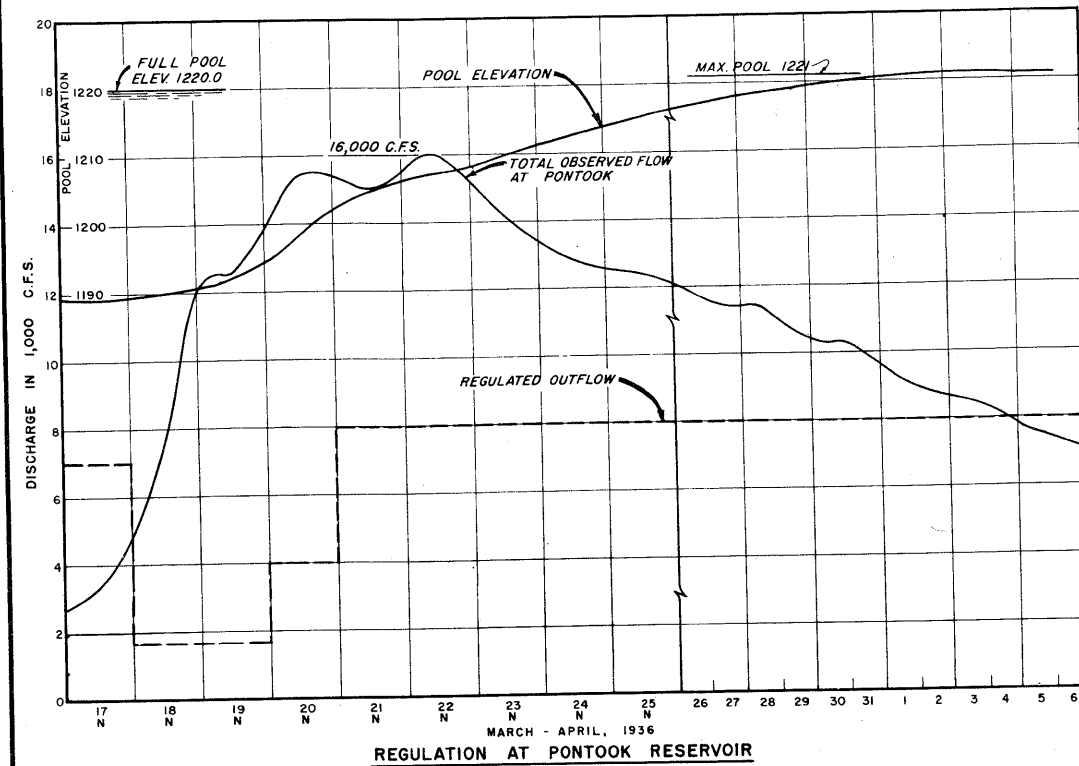
LEGEND

[363] DRAINAGE AREA IN SQUARE MILES

NOTES:

- (1) Includes 24 Square Miles of Local Area
 (2) Includes 13 Square Miles of Local Area

REVISION	DATE	DESCRIPTION	BY
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.			
DR. BY	TR. BY	CK. BY	
	GHD		
PROJECT ENGINEER			
ANDROSCOGGIN RIVER FLOOD CONTROL TYPICAL TRIBUTARY CONTRIBUTION FLOOD			
SUBMITTED BY		APPROVED	
CHIEF, PLANNING & REPORTS BRANCH		CHIEF, ENGINEERING DIV.	
SCALE		SPEC. NO. CIV. ENG. - 19-018	
		DRAWING NUMBER	
SHEET			



REVISION	DATE	DESCRIPTION	BY
U. S. ARMY ENGINEER DIVISION, NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.			
DR. BY	TR. BY	CE. BY	
	M. S.		
PROJECT ENGINEER			ANDROSCOGGIN RIVER FLOOD CONTROL
SUBMITTED BY			RESERVOIR REGULATION
CHIEF, R. & H. SECTION			MARCH 1936 FLOOD
CHIEF, PLANNING & REPLY BRANCH			ANDROSCOGGIN RIVER, MAINE & N.H.
APPROVED	DATE		
CHIEF ENGINEERING DIV.	COL. C.E. DEPUTY DIVISION ENGINEER		
SCALE		SPEC. NO. CIV. ENGR.-B-018	
DRAWING NUMBER		SHEET	

APPENDIX C
ECONOMIC DEVELOPMENT

APPENDIX C
ECONOMIC DEVELOPMENT

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PLATE

	<u>Number</u>
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APPENDIX C

ECONOMIC DEVELOPMENT

1. MAINE

Maine, the largest of the New England states, with an area approximately as large as all the other New England states combined, has less than 10 percent of the region's population. With 51.3 percent of its population classified as urban (1960 Census), the state has the lowest per capita income in New England, 28.2 percent below the regional average and 19 percent below the national per capita (1962 data).

The Androscoggin Basin and the tributary area thereto is economically the most advanced area in the state. With over 41 percent of the state's population residing on only 13 percent of the state's land, the area accounts for 32 percent of the 2,500 concerns listed in the "Buyers Guide and Directory of Maine Manufacturers", published by the Maine Department of Economic Development (1962). Per capita income for the tributary area is 15 percent higher than for the state as a whole or just under the national average.

Androscoggin County which straddles the lower reaches of the river from Livermore Falls almost to tidewater, a distance of 60 miles, or roughly one half of the total stream in Maine, is the second most densely settled county in the state with 181 inhabitants per square mile (1960 Census). The Census designates 82 percent of the population as urban. With the exception of a 7-mile length of river between the lower end of Androscoggin County and tidewater and a 5-mile stretch of the river between Livermore Falls and Riley which cuts across a corner of Franklin County, the remainder of the river in Maine lies in Oxford County.

The two counties together, with a population of 13.5 percent of the entire state, accounted for 19 percent of the value of manufacture added for Maine in 1962. The industry producing this "value added" is concentrated in the Androscoggin River valley. If value added for the plants along the 5-mile stretch of river in Franklin County and the plants along the river between the lower Androscoggin County Line and tidewater is included, the river basin accounts for almost a quarter of Maine's manufacturing production, dollar-wise.

Plate C-1 shows "Value of Manufacture Added" for the state, for Androscoggin County, for Oxford County, and for the two counties combined. The decline in Androscoggin County between 1947 and 1954 is

accounted for by the continuing decline of the textile industry, once a valley mainstay. Since 1957 the industry in the county has become stabilized and in the last four years has started to increase although it has not kept pace with the state as a whole.

In Retail Trade and Selected Services, the pattern for the State and for the river valley counties have followed the same trend as for Value of Manufacture added. The State has shown an overall growth in each of the indices over the past 30 years with a leveling off in the rate of growth in the past 10 years. For the river valley counties there has been an overall growth in both indices in the 21-year period ending in 1960 for which data are available but in the last 6 years of that period the growth in retail trade was small while that in Selected Services was at a rate which was only a third of that for the state as a whole.

Population-wise, the valley has been relatively stable. The tributary area showed a growth of 5.4 percent in the decade 1950-1960. This compares with a state growth of 6.1 percent and a New England Regional growth of 12.8 percent for the same period. In the river valley proper, the growth was slightly over 2 percent with most of it concentrated in the area between Livermore Falls and tidewater. This growth accounted for all the growth in the two counties involved; in fact, overall, the population of Oxford and Androscoggin Counties has declined in the past 20 years.

The future of the river valley can be expected to follow past trends. Paper making, the largest portion of the manufacturing sector of the present economy of the basin will play an even larger role in the future. Announced expenditures for enlarging present plant and constructing new plant in the valley **amounted to more than \$66 million over the past 2 years.**

The increase in paper making is part of a state-wide trend. With 86 percent of Maine's area in forest and an abundance of water in most parts of the state, the raw materials for paper are readily available. A study by the U. S. Forest Service forecasts the following increases in the use of forest products in Maine.

<u>Item</u>	<u>1962 Production</u> (1,000 tons)	<u>2000 Forecast Production</u> (1,000 tons)
Wood Pulp	1626	3180
Paper & Paperboard	1831	3570

A constantly improving network of good roads is available to bring the forest products to the plants. In addition, a good rail network also furnishes such service. Two of the state's railroads, the Bangor and Aroostook and the Maine Central, are adding a fleet of 368 cars which are specially designed for pulp wood. The Maine Central, which is buying 200 of the cars, serves the entire Androscoggin valley in Maine.

The state's overall economic development over the project life is expected to improve over the present time and to approach the National level. An overall growth factor of 1 percent annually in the economy is projected. This represents a composite figure based on the expected growth in Value of Manufacture Added, Retail Trade, Selected Services, per capita income, and population.

For the Androscoggin River valley, the present state of development compared to the state as a whole indicates an economic growth rate somewhat less than the state as a whole even though the valley's prospects are good. Based on current trends, a composite growth rate of 0.75 percent annually in the overall economy is projected over the next 50 years with a leveling trend thereafter.

2. NEW HAMPSHIRE

The economy of the river valley in New Hampshire is almost wholly geared to one paper products company in Berlin. The company's business is stable and its supplies of raw materials ample. Because of the one plant economy, little change in this portion of the valley seems likely and little growth is expected.

Value of Manufacture Added Maine & Selected Counties In 1963 Dollars

\$1 Billion

\$100 Million

Incomplete
Data Available
For This Period

State

Combined Counties

Androscoggin County

Oxford County

1930

1940

1950

1960

PLATE C-1

APPENDIX D

FLOOD LOSSES AND BENEFITS

APPENDIX D

FLOOD LOSSES AND BENEFITS

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4.	RECURRING LOSSES	D-3
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APPENDIX D

FLOOD LOSSES AND BENEFITS

1. DAMAGE SURVEYS

A detailed damage survey was made in the main flood area of the Androscoggin River following the record flood of March 1936. Later surveys were conducted in 1952, 1961, and 1966 to obtain more detailed flood damage information in the river basin and to determine trends of development in the watershed. The surveys consisted of door-to-door interviews, and inspections of the various residential, commercial, rural, and industrial properties in the flooded areas. Information obtained included the extent of areas flooded, description of property, the nature and amount of damages, depths of flooding, high water references, and relationships between the March 1936 flood and other flood stages.

Damage estimates and depths of flooding were generally furnished by property owners and tenants, but investigators prepared alternative estimates when in their judgment, based on property examination, estimates of owners or tenants were unrealistic or unreliable. The investigation also made estimates when information was not available from owners or tenants. Where several properties of similar type were subject to the same depth of flooding, sampling methods were used. The review surveys were concerned principally with changes in use of previously surveyed properties, changes in business activities in the larger industrial plants covered in the original surveys and properties new in the flood area since the original surveys.

Sufficient data were obtained to derive loss estimates for (1) the March 1936 flood stage, (2) a stage 3 feet higher, and (3) intermediate stages where marked increases in damage occurred. The stage at which damage begins, referenced to the March 1936 flood stage, was also determined.

2. LOSS CLASSIFICATION

Flood loss information was recorded by type of loss and location. The types recorded include urban (residential, commercial and public), industrial, highway, rural and utilities.

Primary losses were evaluated, including (1) physical losses, such as damage to structures, machinery, equipment and stock and cost of cleanup and repairs, and (2) non-physical losses such as unrecoverable losses of business and wages, increased cost of operation, and the cost of temporary facilities.

Physical losses and a large part of the related non-physical losses were determined by direct inspection of flooded properties and evaluation of the losses by either the property owners or field investigators or both. The non-physical portions of the primary losses were often difficult to estimate on the basis of available information. When this difficulty existed, the non-physical losses were estimated by utilizing determined relationships between physical and non-physical losses for similar properties in the survey and other areas.

No evaluation was made of intangible losses including items such as possible loss of life, hazards to health, and detrimental effects on national security.

3. EXPERIENCED LOSSES

Following the disastrous flood of 1936, a survey of damages was made by field investigators of the Corps of Engineers. The survey disclosed that this flood caused total experienced damages amounting to \$4,392,000, of which 96% was in Maine and four percent in New Hampshire. About 40 percent of the experienced loss was to industrial properties. Paper, pulp, and textile mills at Brunswick, Topsham, Lisbon Falls, Lewiston, Livermore Falls, Peru, and Rumford, Maine, and at Berlin, New Hampshire, which are major elements in the economy of the basin, were seriously affected. Urban losses of about \$850,000 were experienced, with the major part of this loss being concentrated in the residential and commercial sections of Lewiston, Auburn, and Mexico, Maine. Highways in the basin sustained damages in excess of \$700,000 and railroad damages amounted to \$450,000. These damages included the loss of bridges which in some cases, have been rebuilt at higher elevations. Public utility properties, principally hydroelectric installations of the Central Maine Power Company, suffered damages amounting to \$190,000 with attendant plant shutdown for up to seven weeks. Agricultural losses of \$285,000 were experienced, with farms in Lisbon, Canton, Dixfield, Hanover and Bethel, Maine sustaining the major portion of this loss.

The flood of March 1953, the third highest at Rumford since 1892, caused losses totalling \$2,230,000 in the entire river basin. Flood damages were experienced throughout the entire length of the main river from Berlin, New Hampshire to Brunswick, Maine, and along three of the principal tributaries, the Dead River in New Hampshire and the Swift and Little Androscoggin Rivers in Maine. Flood waters inundated a great many roads causing highway damages in excess of \$150,000 and preventing motor transportation throughout a major portion of the basin for the greatest part of four days. Damages were sustained by industrial properties along the main river of Rumford, Peru, Livermore Falls, Lewiston, Auburn, Lisbon, Topsham, and Brunswick, Maine, and on the Little Androscoggin River at Mechanic Falls. The dam of the Pejepscot Paper Company at Lisbon Falls, Maine was breached. Replacement costs were estimated at \$100,000. The Dead River overflowed streets in the business section of Berlin, New Hampshire, causing damages to a number of stores. The Swift River overflowed the main street of Mexico, Maine necessitating the evacuation of some 100 families and closing of the main commercial section of the town. Several railroad washouts occurred along the Androscoggin River in the Canton-Peru area, below Rumford; large areas of agricultural lands were flooded between Gilbertville and Bethel, Maine, and stream banks were eroded at numerous locations throughout the basin.

4. RECURRING LOSSES

Stage-damage and stage-discharge relationships were developed to reflect the magnitude of recurring losses at varying stages of flooding above and below the reference floods in the studied areas. The recurring losses used in development of the stage-damage relationships reflect economic and physical conditions in the areas at the present time.

The recurring loss from a 1936 flood on the main stem of the Androscoggin River from the Sawmill Dam in Berlin to below Brunswick is estimated at \$13,703,000. Recurring losses by type are listed in Table D-1.

Twenty industrial firms employing over 9,000 persons are located along the river and would sustain substantial damage in the event of a recurrence of the 1936 flood. The industrial activities of these plants produce a diversified line of products including textiles at Lewiston, boots and shoes at Auburn, pulp and paper at Rumford and pulp, paper, and allied products in Berlin.

A summary of total recurring damages listed by damage centers is shown in Table D-2.

TABLE D-1

RECURRING LOSSES BY TYPE

1936 FLOOD
(1966 Price Level)

<u>Type</u>	<u>Recurring Loss</u>
Industrial	\$ 8,863,000
Urban (Commercial, Residential & Public)	2,686,000
Highway	1,096,000
Railroad	370,000
Utilities	621,000
Rural (includes agricultural)	<u>67,000</u>
	\$13,703,000

TABLE D-2

RECURRING LOSSES IN DAMAGE AREAS

1936 FLOOD
(1966 Price Level)

<u>Area</u>	<u>Recurring Loss</u>
Brunswick - Topsham	\$ 3,246,000
Lewiston - Auburn	2,761,000
Livermore Falls	1,444,000
Rumford - Mexico	4,585,000
Shelburne, N.H.	241,000
Gorham - Berlin, N.H.	<u>1,426,000</u>
	\$13,703,000

5. ANNUAL LOSSES

Estimated recurring losses along the river were converted to average annual losses by correlating stage-damage, stage-discharge and discharge-frequency data to derive damage-frequency relationships in accordance with standard Corps of Engineers practices. Plates D-1, D-2 and D-3 show the procedure used in converting recurring stage-damage data to annual losses and benefits. Average annual losses by major damage centers are listed in Table D-3.

TABLE D-3

PRESENT AVERAGE ANNUAL LOSSES

(1966 Price Level)

Brunswick - Topsham, Me.	\$ 160,800
Lewiston - Auburn, Me.	96,400
Livermore Falls, Me.	102,900
Rumford - Mexico, Me.	206,800
Shelburne, N.H.	3,700
Gorham - Berlin, N.H.	<u>161,100</u>
	\$735,000

6. FUTURE ANNUAL LOSSES

Flood losses in the Maine portion of the basin can be expected to increase at least as fast as the overall economic growth rate for the area. As discussed in Appendix C, Economic Development, the overall economy in the basin is expected to grow at a rate of 0.75 percent annually for the next 50 years and then remain stable for the following 50-year period. The total growth of 37.5 percent in 50 years was converted to an average annual equivalent value over the 100-year project life by compound interest methods using an interest rate of $3\frac{1}{8}$ percent. The annual equivalent value so derived amounts to 18.6 percent. Average annual losses adjusted for the expected growth amount to \$830,000 at 1966 price levels.

7. BENEFITS

a. Tangible Flood Damage Prevention Benefits.

Construction of the Pontook project would reduce flood flows along the entire length of the Androscoggin River from Berlin to tidewater and provide substantial protection to presently flood-prone properties. In a recurrence of the record flood of 1936, under today's conditions, the reservoir would prevent \$3.9 million in losses.

Present average annual flood damage prevention benefits have been derived as the difference in annual losses along the river under present conditions and those that would remain after reduction in flood flows by the reservoir. Average annual benefits so derived for the Pontook project are \$209,000.

b. Future Benefits.

When the growth in the Maine portion of the basin over the next 50 years is considered, the benefits at the end of the 50-year period will have grown to \$239,500. Taken as an average annual equivalent value over a 100-year project life, the benefits to growth amount to \$15,000. Total benefits over the life of the project, adjusted for growth, are therefore \$224,000 for a reservoir with 8" of flood control storage. Benefits were also computed in the same manner for reservoirs with varying amounts of storage for purposes of maximizing net benefits. Results are shown in Table D-4.

c. Redevelopment Benefits.

Pontook Dam would be constructed in a portion of New Hampshire, Coos County, which has been designated a Redevelopment Area by the Economic Development Administration under P. L. 89-136. The construction would put to work residents of the area who are unemployed or under-employed and the wages thereto are considered a benefit under current policy. Division records for Civil Works construction over the past 9 years indicate that, for the type of construction involved, the labor costs average 27% of total contract cost. Based on the present estimated construction cost of Pontook, the total labor cost would be \$11,100,000. After discounting for the number of people who would be hired locally (70%) and for the number so hired who would be unemployed or under-employed (75%), a total labor benefit of \$5,800,000 is creditable to the project. As this is to be dispersed over a four-year period, the expenditures are discounted by present worth factors at 3-1/8% interest rate. The discounted value of the benefit is \$5,380,000. Amortized over the 100-year project life, the annual benefit amounts to \$176,000.

d. Intangible Benefits.

In addition to tangible benefits resulting from project construction, important intangible benefits would be realized. Among these are prevention of possible loss of life, prevention of disease caused by flooding of polluted water, and the stabilizing effect on community life in the valley from the reduction in the flood threat.

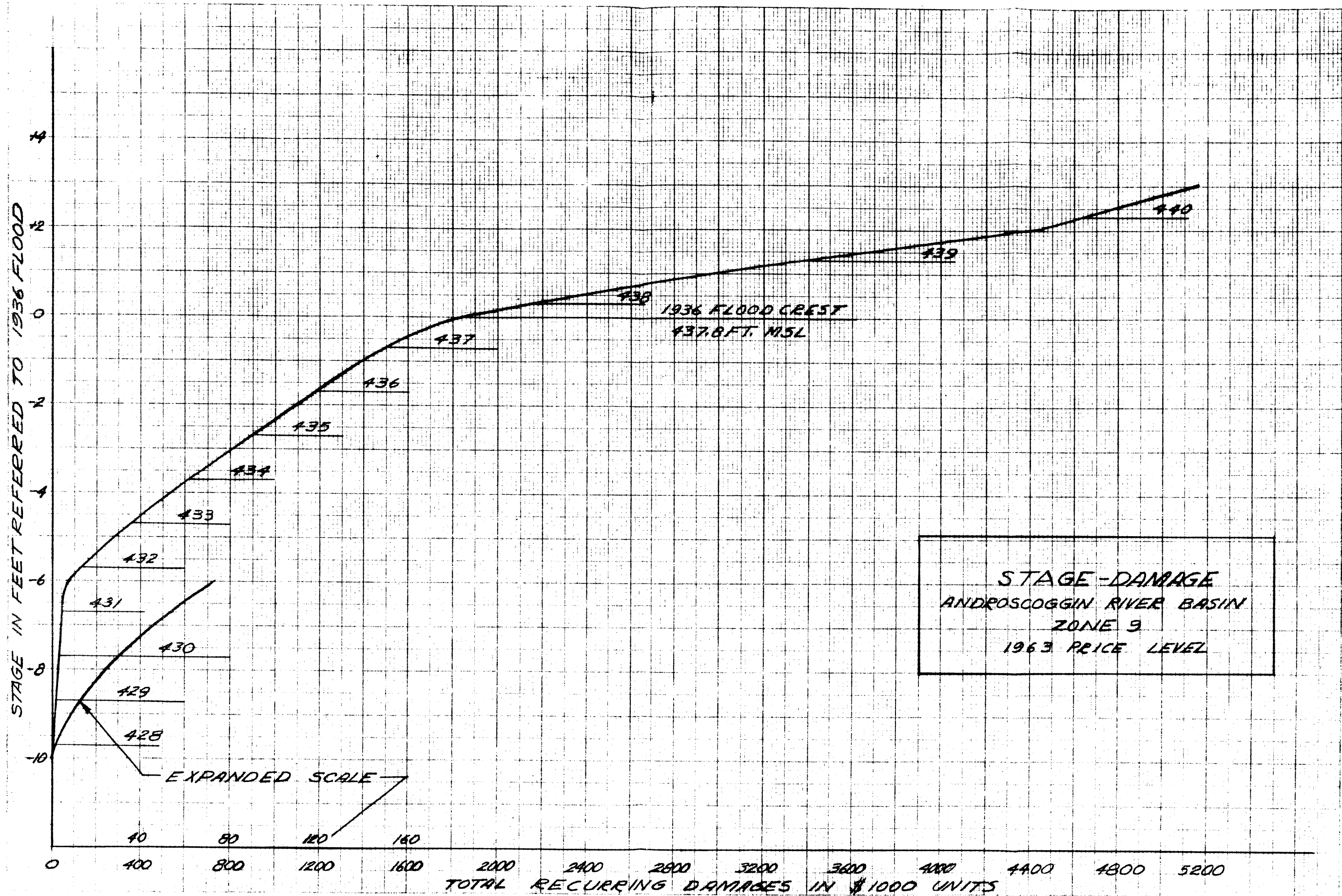
TABLE D-4

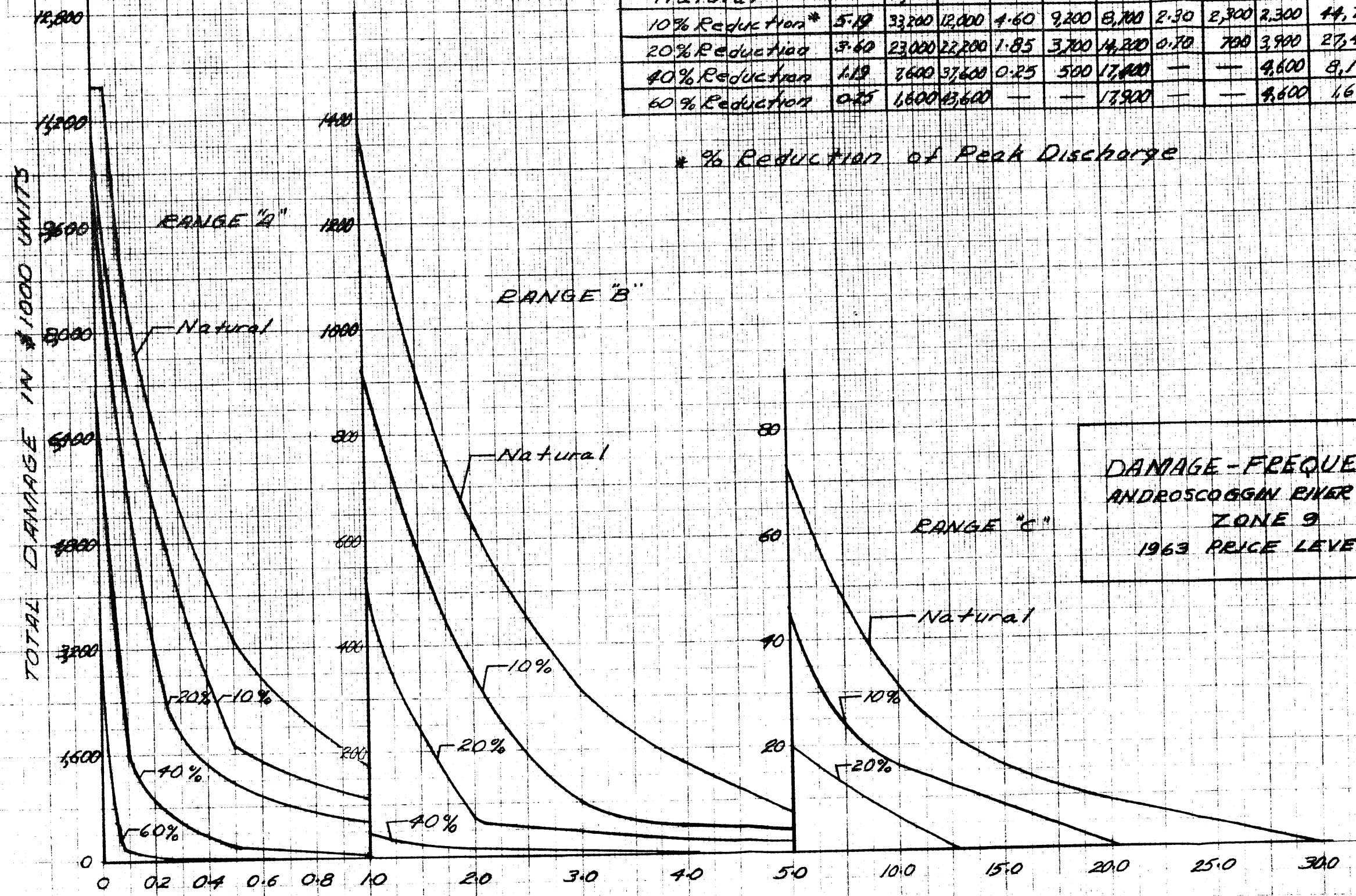
	<u>Spring F. C. Storage in Pontook-Inches</u>	<u>Relative Effectiveness %</u>	<u>F.C. Benefits</u>
Basic Plan	8	100	\$224,000
Alternate Plan 1	0	10	25,000
Alternate Plan 2	4	50	125,000
Alternate Plan 3	12	105	241,000
Alternate Plan 4	8*	90	202,000
Alternate Plan 5	10.9**	104	239,000

*Using Pontook only for flood control; existing regulation of upstream reservoirs.

**Derivation of F. C. storage at Pontook for Plan 5 (report plan) based on providing 6" of storage over net drainage areas tributary to Umbagog and Pontook.

	<u>D.A.</u>	<u>Inches</u>	<u>A-F</u>	<u>MSF</u>
Umbagog	359	3.7	70,700	1,171
Pontook	<u>170</u>	<u>10.9</u>	<u>98,400</u>	<u>1,630</u>
Totals	529	6.0	169,100	2,801

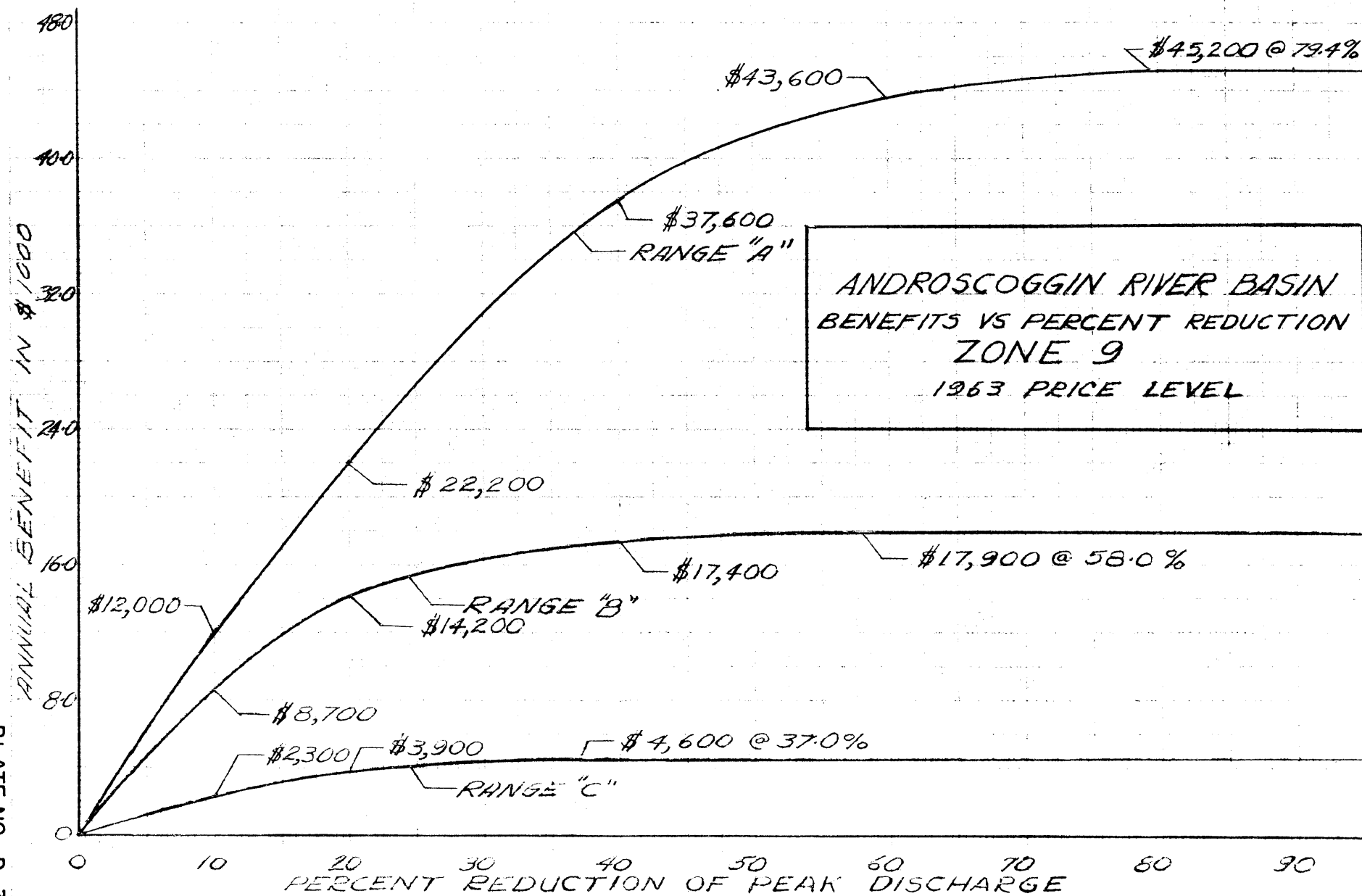




	RANGE "A" 1" = \$6,400			RANGE "B" 1" = \$2,000			RANGE "C" 1" = \$1,000			TOTAL ANNUAL	
	AREA	LOSS	BEN	AREA	LOSS	BEN	AREA	LOSS	BEN	LOSS	BENEFIT
Natural	7.06	45,200	—	8.95	17,900	—	4.60	4,600	—	\$67,700	—
10% Reduction*	5.19	33,200	12,000	4.60	9,200	8,700	2.30	2,300	2,300	44,700	\$23,000
20% Reduction	3.60	23,000	22,200	1.85	3,700	14,200	0.70	700	3,900	27,400	40,300
40% Reduction	1.19	7,600	37,400	0.25	500	17,400	—	—	4,600	8,100	59,600
60% Reduction	0.25	1,600	43,600	—	—	17,900	—	—	4,600	1,600	66,100

* % Reduction of Peak Discharge

DAMAGE-FREQUENCY
ANDROSCOGGIN RIVER BASIN
ZONE 9
1963 PRICE LEVEL



APPENDIX E

PONTOON DESCRIPTION AND COST ESTIMATE

APPENDIX E

PONTOOK DESCRIPTION AND COST ESTIMATE

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PERTINENT DATA

PONTOOK DAM & RESERVOIR

ANDROSCOGGIN RIVER BASIN

MAIN DAM

<u>Drainage Area, sq. mi.</u>	1,215 gross 170 net below Errol Dam
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Elevations, mean sea level datum

Top of dam	1230
Full pool	1220
Min. power pool	1180
Streambed at dam	1124
Normal tailwater	1121

Reservoir Areas

	<u>acres</u>	<u>sq. mi.</u>
Full pool	7,470	11.7
Min. power pool	2,760	4.3

Reservoir Storage, acre-feet

Joint use: power, flood control, & recreation	207,000
Dead	31,000

Critical flow period

7/40 - 6/43

Maximum gross head, feet	99
Average net head, feet	93
Net head during critical low flow period, feet	79
Minimum net head, feet	57

Flows, c. f. s.

Minimum dependable	1,724
Usable dependable	1,513
Max. discharge at rated capacity	42,000

Power Production

Installed capacity, kw	300,000
Average annual energy, kwh	115,000,000
Minimum December energy, kwh	9,047,000
Capacity factor, average annual (5-day per week basis)	6.13%
Minimum December load factor (5-day per week basis)	5.78%

Embankments

	<u>Dam</u>	<u>Dike</u>
Length - feet	1,170	830
Volume - cu. yds.	750,000	50,000

Tainter Gates

Number	3
Size, each - feet	40x40
Sill Elev., msl	1,180

Turbine Intake Gates

Number	9
Size, each - feet	13x40

Road Relocation - miles 13.5

Road Raised to Higher Level - miles 2.5

Recreational Development

Main reservoir shoreline - miles	56
Estimated annual visitation, initial	110,000
" " " , ultimate	404,000

REREGULATING DAM

Top of dam elev., msl	1136
Maximum height, feet	53
Full Pool Elev., msl	1121
Total capacity - acre feet	16,300
Usable capacity - act. ft. (pondage)	15,000
Usable dependable flow, cfs	1,724
Tainter Gates	
Number	3
Size, each - feet	45x26
Sill elev., msl	1095

REAL ESTATE REQUIREMENTS

Main dam and reservoir, land - acres	9,300
General Recreation, land - acres	2,000
Reregulating dam and reservoir, land - acres	1,900
Main dam reservoir improvements - units	57
Reregulating dam reservoir improvements - units	58

APPENDIX E

PONTOOK DESCRIPTION AND COST ESTIMATE

1. MAIN DAM AND RESERVOIR

a. Dam. The Pontook dam site is located on the Androscoggin River in the town of Dummer, New Hampshire. The dam, extending from the west abutment, with a top elevation of 1230 feet above mean sea level, would be of rock-fill construction, approximately 1,170 feet long and with a maximum height of 106 feet above the river bed. A powerhouse would be located adjacent to the dam section. The intakes to the powerhouse turbines would consist of nine 13' x 40' gated openings with sills at elevation 1091. An ogee spillway, with crest at elevation 1180, surmounted by three 40' x 40' tainter gates, would be constructed adjacent to the powerhouse to maintain the power pool level and to release flows in excess of the needs of the turbines during flood periods. Between the powerhouse and spillway, a log sluice with a 6' x 18' gate would be provided to pass logs through the dam. A 140'-long concrete non-overflow section adjacent to the spillway would complete the closure to the east abutment. A rock-fill dike, with a top elevation of 1230, approximately 830 feet long and a maximum height of 30 feet, would be constructed to close a saddle about 3,000 feet northeast of the dam. A general plan of the dam and dike is shown on Plate E-1 of this appendix.

b. Reservoir. The reservoir at full pool elevation 1220, would be about 16 miles long, have a surface area of 7,470 acres, and a gross capacity of 238,000 acre-feet, of which 207,000 acre-feet, between elevations 1220 and 1180 would be used jointly for power, flood control, and recreation purposes. The operating rule curve for regulating the reservoir provides flood control storage varying from zero at certain periods in the summer and winter to a maximum of 98,400 acre-feet in the spring, equivalent to 10.9 inches of runoff from the net drainage area of 170 square miles between Errol Dam and the project site. By raising existing storage in accordance with rule curves described and shown in Appendix F, a total volume of 532,400 acre-feet, equivalent to 8.2 inches on the gross drainage area of 1,215 square miles, would be available in the spring for storage of flood waters and snow melt. As a test of the effectiveness of this joint-use operation, the maximum flood of record (March 1936) was routed through the combined storage. Under this method of operation, all upstream reservoirs and Pontook would fill, with the latter rising to one foot above full pool. (See paragraph 10h (1) of Appendix B.) By following the prescribed rule curves, the Pontook project would also be filled by the first of July (elevation 1220) for the summer recreation season. The suggested operation

thereby maximizes the flood control and recreation benefits without significantly affecting the power aspects.

With a power pool elevation of 1220 in the reservoir and a tailwater elevation of 1121 at the powerhouse, a total gross head of 99 feet would be developed. Three 100,000 kilowatt generating units - a total of 300,000 kilowatts - would be installed in the powerhouse. The plant would produce an average of 115,000,000 kilowatt-hours annually. A plan and section of the powerhouse are shown on Plate E-2 of this appendix. Hydroelectric power studies for this project are described in Appendix F.

2. REREGULATING DAM AND POOL

a. Dam. The dam site is located about 6.5 miles downstream from the main dam on the Androscoggin River in the town of Milan, New Hampshire. The dam would be of rolled earth-fill, approximately 2200 feet long, having maximum height of 53 feet above the river bed, and a top elevation of 1136. A tainter-gated spillway, 135 feet long with sill at elevation 1095 would be constructed adjacent to the dam. Three 45' x 26' tainter gates on the spillway would be used to regulate the discharge from the pool. A 6' x 20' gate provides for sluicing logs through the dam. A general plan of the reregulating dam is shown on Plate E-2 of this appendix.

b. Pool. The full pool at elevation 1121 would extend up the river to the main dam, have a surface area of 1,160 acres, and a gross capacity of 16,300 acre-feet. To meet the uniform flow requirements established for the upper Androscoggin River by interests having riparian rights along the waterway, a usable storage capacity of 15,000 acre-feet, between elevation 1121 and 1101, would be utilized to reregulate releases from the powerhouse to uniform releases of up to 2,500 cubic feet per second. Gate discharges would be adjusted as required for the sluicing of logs, ice, or debris through the sluice gate.

3. GEOLOGY AND SOILS

a. Geology of the Area.

(1) Main Dam and Dike. The site of the main Pontook dam is approximately one mile downstream from an existing timber crib logging dam, an area in which private interests investigated other dam alignments

in some detail in 1929, and in 1946 through 1949. The latter investigations were made for hydroelectric power developments utilizing the saddle between Holt and Veezey Hills for a canal leading to penstocks and powerhouse located about two miles downstream. In 1953, the New England Division, in studies for the New England-New York Inter-Agency Committee report, investigated this area for power development and made two test borings to check foundation conditions. In 1964, the Public Service Company of New Hampshire applied to the Federal Power Commission for a preliminary permit to restudy the site.

The course of the river through the damsite is post-glacial, flowing on a pavement of boulders derived from erosion of thick glacial till deposits. The main abutments are formed by the till slopes of Bickford Hill on the right or west bank and Holt Hill on the left or east bank of the river. The left bank is formed by the face of a sand terrace which extends for a width about 200 feet to its contact with the till slope. Bedrock is exposed high on Bickford Hill and in the high saddle to be diked east of Holt Hill. It is not exposed at low elevations in this stretch of river except at a location about one mile downstream where the rock surface has been uncovered by deep erosion in the right bank and deflects the river abruptly eastward.

(2) Reregulating Dam. The site is located approximately 6.5 miles downstream from the main dam. Both abutments are rock-controlled. The main portion of the embankment would be constructed on the wide flood plain of the Androscoggin River.

b. Geological Investigations.

(1) Main Dam and Dike. Geological reconnaissance was first made of the selected damsite in October of 1961 and was the basis for distribution of preliminary subsurface explorations shown in layout and recorded on Plate E-3. None of the topographic mapping nor subsurface explorations made for prior investigations in this stretch of river are applicable to this site. The topography used was taken from U. S. Geological Quadrangle for Milan, New Hampshire adjusted to a surveyed profile within the damsite limits.

The dike site is located in a high saddle between Holt and Veezey Hills previously considered for a spillway location. Two borings (FD-4 and FD-5) were made for this purpose. These explorations and applicable others previously made by private interests in the saddle vicinity are shown on plan and recorded on Plate E-4.

(2) Reregulating Dam. A previously selected alignment was located approximately 3.5 miles downstream of the main dam. This site was surveyed in profile and three test borings were made in the river section and right bank where structures were proposed. The location of these explorations and their records in relation to the surveyed profile are shown on Plate E-4.

The present alignment is located approximately 6.5 miles downstream of the main dam. No surveys or subsurface investigations have been made at this site. Reconnaissance and topographic considerations indicate subsurface similarities of the two sites.

c. Foundation Conditions.

(1) Main Dam. Dense, impermeable glacial till is available at nominal depths for cut-off under the embankment. The subsurface conditions shown in geologic section on Plate E-3 are believed generally applicable throughout the damsite limits. The relatively pervious zones encountered at depth within the till and yielding to produce artesian head in two of the borings probably do not have any great continuity. However, preliminary embankment design provides for a system of relief wells at the downstream toe of the embankment.

Bedrock does not outcrop in the damsite area, but from a deep preglacial channel under the right abutment the rock surface rises with the left abutment to within about 20 feet of ground surface at height of dam. Power and spillway structures would be located on or in rock on the left abutment. The bedrock cores, although schistose in structure, are generally fine-grained and relatively massive. No loss of drill water occurred in coring operations and recoveries were generally in the 90-100 percent range with sections of core recovered in lengths up to 5 feet. The dip of schist foliation is 50 to 60 degrees and strike as observed in outcrops remote from the damsite is indicated to be north-easterly about 70 degrees. This orientation of rock structure at about a right angle to the river, coupled with an apparent sound and massive condition, indicates at this stage of investigation no major problems of seepage control, foundation bearing, or structure excavations.

(2) Dike. The saddle dike (30 feet in height) would be located about a mile remote from the left or east abutment of the dam. As shown in profile on Plate E-4, relatively impervious materials of a till-like nature are expected to occur at accessible depths for cut-off to control seepages through the foundation.

(3) Reregulating Dam. Bedrock outcrops or is at shallow depths on the abutments but the rock surface is unpredictable and probably deeply buried under the wide floodplain. Structures are planned on the right abutment where the rock surface is indicated to have some extension at available depth toward the floodplain. The long low (53' high at riverbed) earthen embankment section of the dam extending across the flood plain would be founded on loose interbedded outwash deposits similar to those depicted in Geologic-Log Section D-D, Plate E-4.

d. Construction Materials. Impervious materials in the form of glacial till and overlying materials of a random nature would be available from required excavations and from borrow areas as necessary which can be established conveniently near embankment locations. Pervious materials in the form of sands and gravelly sands occur in abundance in terraces which have been worked on the left bank of the river about 4 miles downstream from the damsite. About 4 miles upstream from the damsite, and bordering the reservoir, there are two large depositional projections into the west side of the valley consisting of gravelly sands with gravel strata, one of which has been worked for road construction. However, since gravelly materials are relatively scarce in this region, it is expected that these latter deposits would be largely worked out for the reconstruction of State Highway Route No. 16 considered in this report. Other potential sources of sands and gravels occur in and along the Ammonoosuc River in West Milan and vicinity at a haul distance of 5 to 10 miles. The nearest commercial source of natural and processed materials is operating in terrace deposits at Gorham, New Hampshire located down river at a haul distance of about 16 miles. Materials from this source have previously been tested and approved for use in concrete at other planned civil works projects in northeastern Vermont and northwestern New Hampshire. However, the estimated overall concrete quantity of about 310,000 cubic yards requires consideration of near site production. Fine aggregates would be available from extensive deposits of gravelly sands in terrace remnants located about 4 miles downstream from the main dam. Production in large quantity of coarse aggregates may require quarrying in igneous or volcanic rocks that occur within 4 miles of the main dam.

Materials for rock slope protection and rock-fills would be provided from required rock excavations. The rock is structurally a schist but its relatively massive, fine-grained quartzitic nature should provide fragmentation and durability suitable for slope protection.

4. REAL ESTATE

a. Character. Land in the project area includes woodland, very little farmland, swamp areas, and a mowed field utilized as an emergency landing field. The project area also includes a privately-owned, single lane, steel girder bridge, a breached wood crib dam, year-round residences, seasonal homes, camps and cottages, one overnight cabin establishment, cemeteries, a portion of a small municipal airport, one large lodge, a Grange Hall, and a gas station.

b. Taking. A plan of the guide taking lines established for the project is shown on Plate 2 of the main report with use of land as follows:

(1) Main Dam and Reservoir. A total of 11,300 acres would be acquired in fee. Of this, 9,300 acres of joint-use land would include the full pool at elevation 1220 plus a 300-foot strip along the shore of the pool, the damsite and work areas, and the relocation of Route 16. An additional 2,000 acres would be acquired for general recreation purposes.

(2) Reregulating Dam and Pool. Approximately 1,900 acres would be acquired for the pool area at elevation 1121, for a 300-foot strip along the shore of the pool, for the dam site, and for appurtenant structures, including the relocation of a portion of Route 16 on the west bank and of several secondary roads on the east bank of the river.

c. Mineral Rights. A current field inspection revealed that no mining of minerals is apparent in the required areas.

d. Existing Dam. The Public Service Company of New Hampshire owns a breached dam in the reservoir area. The pond created by the dam was formerly used to store pulp logs which are now transported by truck. The current value of the dam and pond is estimated at \$10,000.

e. Gravel Pit. There is one commercially operated gravel pit within the reservoir area off Route 16 in the town of Dummer.

f. Severance Damage. The land that would be acquired in fee in the main dam project area would remove all of the small ownerships, leaving only the three large timber land ownerships, Brown Company, Pingree, and Coe. Severance damage for this area is estimated to be nominal. For the reregulating dam area, the severance damage is estimated to be \$30,000.

g. Resettlement.

(1) Main Dam. There would be approximately 60 units eligible for resettlement at an estimated \$675 each, for a total resettlement cost of \$40,000.

(2) Reregulating Dam. Resettlement of 58 units, at costs varying from \$200 to \$1,000, and the Berlin Municipal Airport structures, at a cost of \$11,000, results in a total resettlement cost of \$50,000.

h. Valuation. The valuations of property are based on the Market Data approach, and on a study of recent sales.

(1) Main Dam

(a) Improvements

3 Residences (including outbuildings)	\$ 21,000
48 Summer Cottages and Camps	93,000
1 Farm (including outbuildings)	5,000
3 Commercial	34,000
1 Boat House	300
1 Barn	700
<u>57 Improvements - Total Estimated Cost</u>	<u>\$154,000</u>

(b) Land

Improved lots	100 acres @ \$700	\$ 70,000
Gravel pits	10 acres @ 200	2,000
Emergency landing field	10 acres @ 100	1,000
Tillage	150 acres @ 50	7,500
Woodland	8,000 acres @ 60	480,000
Swamp	2,050 acres @ 10	20,500
Roads and River	<u>980 acres @ 0</u>	<u>0</u>
Total Estimated Cost	11,300 acres	\$581,000

(2) Reregulating Dam

(a) Improvements

42 Residences	\$257,000
3 Camps	7,000
11 Farms	115,000
1 Grange Hall	9,000
1 Municipal Airport Structures	45,000
<u>58 Improvements - Total Estimated Cost</u>	<u>\$433,000</u>

(b) Land

Improved lots	60 acres	\$ 76,000
Tillage	570 acres	46,000
Pasture and		
Woodland	900 acres	45,000
Municipal Airport	80 acres	120,000
Roads and River	<u>290 acres</u>	<u>0</u>
Total Estimated Cost	1,900 acres	\$287,000

i. Acquisition Costs. Experience in other reservoir areas has indicated that administrative costs of acquisition average \$1,000 per tract including mapping, survey, title evidence, appraisal, negotiation, closing, condemnation, and administrative overhead. Total costs are estimated at \$42,000 for the main dam and \$93,000 for the reregulating dam.

j. Summary of Real Estate Costs. A summary of the estimated costs of real estate for the Pontook project is given in Table E-1. Contingencies are estimated at 20 percent.

TABLE E-1
SUMMARY OF REAL ESTATE COSTS

	<u>Thousand Dollars</u>			
	<u>Joint Use</u>	<u>Power(1)</u>	<u>Recreation</u>	<u>Total</u>
Land and improve- ments	\$ 659	\$ 720	\$ 76	\$1,455
Existing dam	10	0	0	10
Severance	0	30	0	30
Resettlement	40	50	0	90
Contingencies	123	142	15	280
Acquisition	33	93	9	135
Totals	\$ 865	\$1,035	\$100	\$2,000

(1) Specific costs for reregulating dam.

k. Salvage Value. Due to uncertainties on resale value and costs of disposition in the future, no salvage value was assigned to project lands at the end of the economic life of the project.

5. RELOCATIONS

a. Cemeteries. There are no cemeteries within the project land-taking limits of the main dam and reservoir. There are four cemeteries containing an estimated 840 graves within the limits of the land taking for the reregulating dam and reservoir. Only one of these cemeteries, containing an estimated 50 graves, falls within the flooded area. The remaining cemeteries fall within the 300-foot buffer strip and would be considered for exclusion during design stage.

b. Roads. Route 16 and secondary roads that would be affected and the proposed relocations are indicated on Plate 2 in the main report. Approximately $13\frac{1}{2}$ miles of Route 16 northerly from the main dam would be relocated and about $2\frac{1}{2}$ miles would be raised. An access road would be provided between relocated Route 16 and an existing, privately-owned, single-lane, steel girder bridge that spans the Androscoggin River. The bridge, requiring reconstruction to above full pool elevation, is utilized for logging purposes. About one mile of Route 16 and about 5 miles of a secondary road

located on the east bank of the river would be relocated outside of the re-regulating dam and pool area. The cost of relocated Route 16 is based on a paved width of 24 feet with 5-foot shoulders.

c. Utilities. Utilities requiring relocation consist of electric service and telephone lines along existing roads and a 115 kv transmission line within the limits of the full pool area.

6. COST ESTIMATE

a. Basis of Estimate. Topographic maps of the U. S. Geological Survey and U. S. Army Map Service were supplemented by a field survey of the centerline profile of the dam and dike areas. Foundation conditions were determined by borings and field reconnaissance. Quantities of the principal construction items were estimated on the basis of preliminary design plans which would provide safe structures for the given conditions and hydraulic criteria. The estimate on clearing is based on complete clearing within the limits of the full pool, for structures, and for access. A four-year construction period was assumed for purposes of determining the Federal investment.

b. Unit Prices. Unit prices are based on average bid prices for similar work in the same region, adjusted to 1966 price levels. Costs of electrical, mechanical, and hydraulic equipment was obtained from published prices and consultations with manufacturers.

c. Contingencies, Engineering, and Overhead. To cover contingencies, construction and relocation costs have been increased by 20 percent. The cost of engineering, design, supervision and administration, has been based on knowledge of the site and experience on similar projects.

d. Annual Charges. Annual charges are based on an annual interest rate of 3-1/8 percent with the cost of the project amortized over an estimated 100-year useful economic life. An allowance is made for maintenance, operation, and major replacement costs and for tax loss on lands transferred to Federal ownership. The cost for replacement of items estimated to have a life less than the life of the project is included as major replacements. Included also is an item for the net loss to fish and wildlife resources caused by the Pontook project as explained in Appendix H.

e. Cost Estimate. A breakdown of costs of property and damages is given in paragraph 4 of this appendix and is summarized in Table E-1. A breakdown of the major construction items, together with their estimated cost is given in Table E-2.

f. Cost Allocation. It is not possible to allocate costs to the various purposes since the comparability test shows that the separable cost of adding hydroelectric power to the project is greater than the cost of an equivalent comparably-financed pumped storage plant (based on values provided by the Federal Power Commission) as shown in Exhibit 1 of Attachment I in the Main Report resulting in a non-justified project. Table E-3 shows the beginning of allocation of costs among project purposes to the point of comparability between the separable power cost and alternative power cost.

TABLE E-2

FIRST COST - PONTOOK PROJECT
(1966 Price Level)

1. LANDS & DAMAGES (Itemized in Table E-1)

Lands and improvements	\$1,455,000
Existing dam	10,000
Severance	30,000
Resettlement	90,000
Acquisition	135,000
Contingencies	<u>280,000</u>
TOTAL - LANDS & DAMAGES	\$2,000,000

2. RELOCATIONS

a. Roads

Relocation of Route 16	\$3,100,000
Raise portions of existing Route 16	400,000
Contingencies	<u>700,000</u>
TOTAL - Roads	\$4,200,000

TABLE E-2 (cont'd.)

2. RELOCATIONS (continued)

b. Utilities & Structures

Relocation of 115 KV transmission line and utility lines	\$ 130,000
Relocation of Brown Co. logging bridge	470,000
Contingencies	150,000
TOTAL - Utilities & Structures	\$ 750,000
Sub-total (a & b)	\$4,950,000
Engineering & Design	320,000
Supervision & Administration	430,000
TOTAL - RELOCATIONS	\$5,700,000

3. RESERVOIR CLEARING

7,000 ac. @ \$375	\$2,625,000
Contingencies	525,000
	\$3,150,000
Engineering & Design	210,000
Supervision & Administration	240,000
TOTAL - RESERVOIR CLEARING	\$3,600,000

4. <u>DAM, SPILLWAY, AP- PROACH AND TAILRACE</u>	<u>Estimated Quantity</u>	<u>Unit</u>	<u>Unit Price</u>	<u>Estimated Amount</u>
Site preparation	70	ac.	1,000	\$ 70,000
Stream control	1	job	L. S.	300,000
Earth exc. (common)	3,100,000	c. y.	0.50	1,550,000
Compacted gravel fill (borrow)	130,000	c. y.	2.20	286,000
Gravel bedding (borrow)	30,000	c. y.	3.40	102,000
Embankment, rolled	480,000	c. y.	0.20	96,000
Rock exc. (open cut)	440,000	c. y.	2.25	990,000
Random fill & backfill	125,000	c. y.	1.00	125,000
Rock placing				
Rock fill	360,000	c. y.	0.25	90,000
Rock filter (process and place)	40,000	c. y.	3.00	120,000
Rock slope protection	50,000	c. y.	0.60	30,000
Concrete, mass.	165,000	c. y.	42.00	6,930,000

TABLE E-2 (cont'd.)

4. <u>DAM, SPILLWAY, AP- PROACH AND TAILRACE</u> (cont'd.)	<u>Estimated Quantity</u>	<u>Unit</u>	<u>Unit Price</u>	<u>Estimated Amount</u>
Concrete, reinf.	5,000	c. y.	65.00	\$ 325,000
Power intake				
Trash racks	1	Job	L. S.	980,000
Gates & hoists	1	Job	L. S.	2,360,000
Gantry crane	1	Job	L. S.	450,000
Log sluice intake				
Sluiceway	1	Job	L. S.	25,000
Gate & hoist	1	Job	L. S.	35,000
Log driving facilities	1	Job	L. S.	75,000
Spillway outlet				
Gates & hoists	1	Job	L. S.	580,000
Bridge	1	Job	L. S.	170,000
Chain link fence	1	Job	L. S.	137,000
Line drilling	1	Job	L. S.	6,000
Service road	1	Job	L. S.	40,000
Relief wells	1	Job	L. S.	150,000
Contingencies				3,208,000
				<u>\$19,230,000</u>
Engineering & Design				1,150,000
Supervision & Administration				1,520,000
TOTAL - DAM COST				<u>\$21,900,000</u>
5. <u>REREGULATING DAM</u>				
Reservoir clearing	120	Ac.	500.	60,000
Site preparation	1	Job	L. S.	33,000
Stream control	1	Job	L. S.	56,000
Earth excavation (common)	360,000	c. y.	0.50	180,000
Impervious borrow	280,000	c. y.	0.75	210,000
Gravel bedding	70,000	c. y.	2.50	175,000
Rock excavation	80,000	c. y.	2.75	220,000
Embankment, rolled	320,000	c. y.	0.20	64,000
Rock placing	100,000	c. y.	0.70	70,000
Concrete, mass.	15,000	c. y.	47.00	705,000
Concrete, reinforced	1,600	c. y.	75.00	120,000
Line drilling	4,000	S. F.	4.00	16,000
Road relocation	1	Job	L. S.	1,380,000
Cemetery relocation	1	Job	L. S.	105,000
Utilities relocation	1	Job	L. S.	30,000

TABLE E-2 (cont'd.)

5. <u>REREGULATING DAM</u> (cont'd.)	<u>Estimated Quantity</u>	<u>Unit</u>	<u>Unit Price</u>	<u>Estimated Amount</u>
Spillway bridge	1	Job	L. S.	\$ 90,000
Tainter gates and machinery	1	Job	L. S.	420,000
Log sluice gate	1	Job	L. S.	36,000
Contingencies				790,000
				<u>\$4,760,000</u>
Engineering & Design				285,000
Supervision & Administration				355,000
TOTAL - REREGULATING DAM				<u>\$5,400,000</u>
6. <u>POWER PLANT</u>				
a. <u>Powerhouse</u>				
Earch exc. (common)	50,000	c. y.	0.50	\$ 25,000
Rock exc. (open cut)	80,000	c. y.	2.25	180,000
Reinf. concrete	4,400	c. y.	65.00	286,000
Mass conc. substructure	120,000	c. y.	42.00	5,040,000
Superstructure	1,800,000	c. f.	0.75	1,350,000
Powerhouse crane	1	Job	L. S.	506,000
Draft tube gantry crane	1	Job	L. S.	580,000
Draft tube gates	1	Job	L. S.	1,800,000
Misc. power plant equipment	1	Job	L. S.	690,000
Line drilling	27,000	S. F.	4.00	108,000
Contingencies				2,085,000
				<u>\$12,650,000</u>
Engineering & Design				760,000
Supervision & Administration				890,000
TOTAL - Powerhouse				<u>\$14,300,000</u>
b. <u>Turbines & Generators</u>				
3 each 100,000 KW turbine and generator sets installed	1	Job	L. S.	11,700,000
Transformers & switching equipment installed	1	Job	L. S.	3,250,000
Station service & low volt- age equipment	1	Job	L. S.	1,100,000
Contingencies				1,390,000
				<u>\$17,440,000</u>
Engineering & Design				600,000
Supervision & Administration				1,160,000
TOTAL - Turbines & Generators				<u>\$19,200,000</u>
TOTAL - POWER PLANT				<u>\$33,500,000</u>

TABLE E-2 (cont'd.)

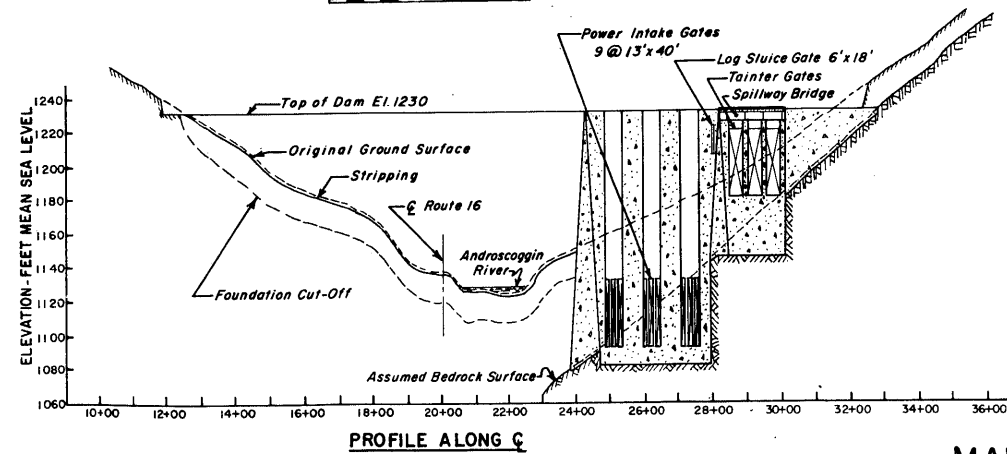
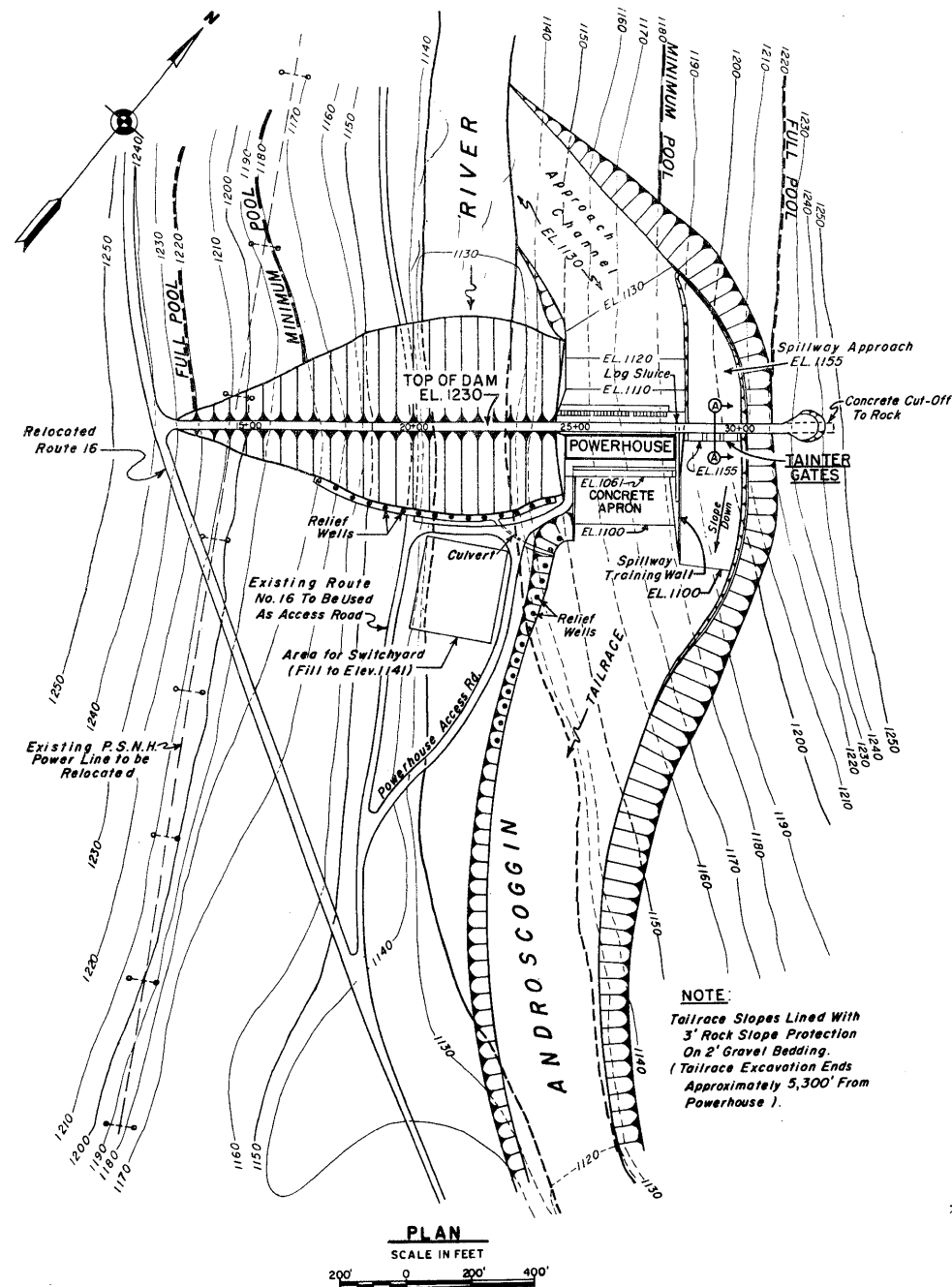
7. <u>RECREATION FACILITIES -</u>				
<u>Initial Development (For de-</u>	<u>Estimated</u>		<u>Unit</u>	<u>Estimated</u>
<u>tails, see Appendix G)</u>	<u>Quantity</u>	<u>Unit</u>	<u>Price</u>	<u>Amount</u>
Day use - park area				\$ 402,250
Camping area				119,000
Boat launching & marina area				37,000
Administration & maintenance area				53,000
Water supply				68,000
Miscellaneous - Trails, landscaping, etc.				14,750
Contingencies				136,000
				<u>\$ 830,000</u>
Engineering & Design				90,000
Supervision & Administration				80,000
TOTAL - RECREATION FACILITIES				<u>\$ 1,000,000</u>
8. <u>BUILDINGS, GROUNDS & UTILITIES</u>				
	1	Job	L.S.	\$ 110,000
Contingencies				20,000
				<u>\$ 130,000</u>
Engineering & Design				10,000
Supervision & Administration				10,000
TOTAL - BUILDINGS, GROUNDS & UTILITIES				<u>\$ 150,000</u>
9. <u>PERMANENT OPERATING EQUIPMENT</u>				
	1	Job	L.S.	\$ 34,000
Contingencies				6,000
				<u>\$ 40,000</u>
Engineering & Design				5,000
Supervision & Administration				5,000
TOTAL - PERMANENT OPERATING EQUIPMENT				<u>\$ 50,000</u>
TOTAL PROJECT FIRST COST				\$73,300,000

NOTE: This estimate does not include preauthorization study costs
of \$50,000

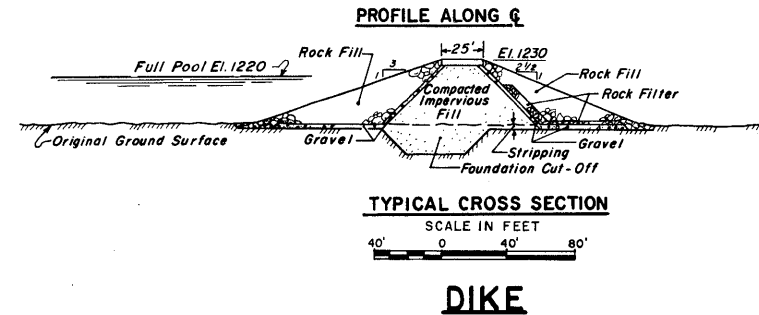
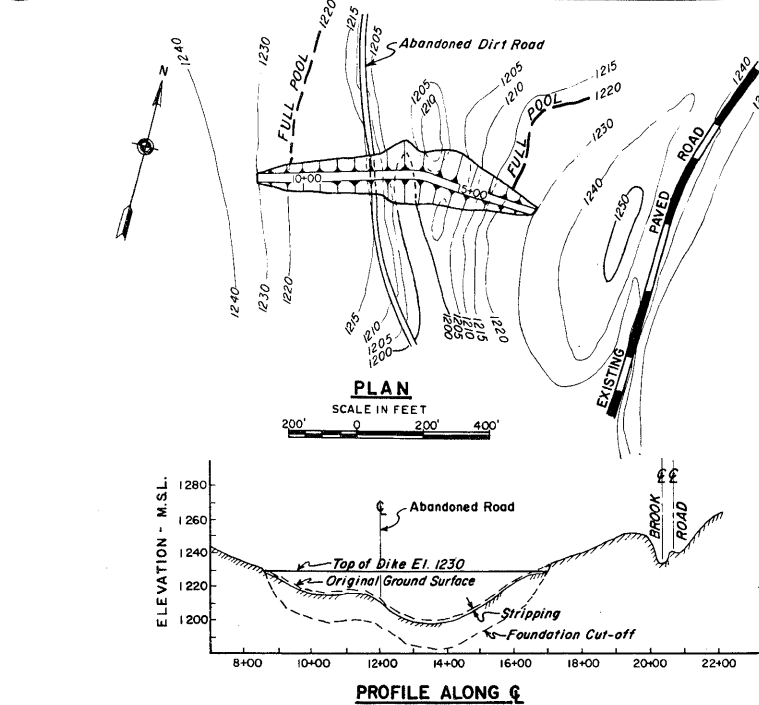
TABLE E-3

PONTOOK PROJECT
COST ALLOCATION
(in \$1,000 at 1966 Price Level)

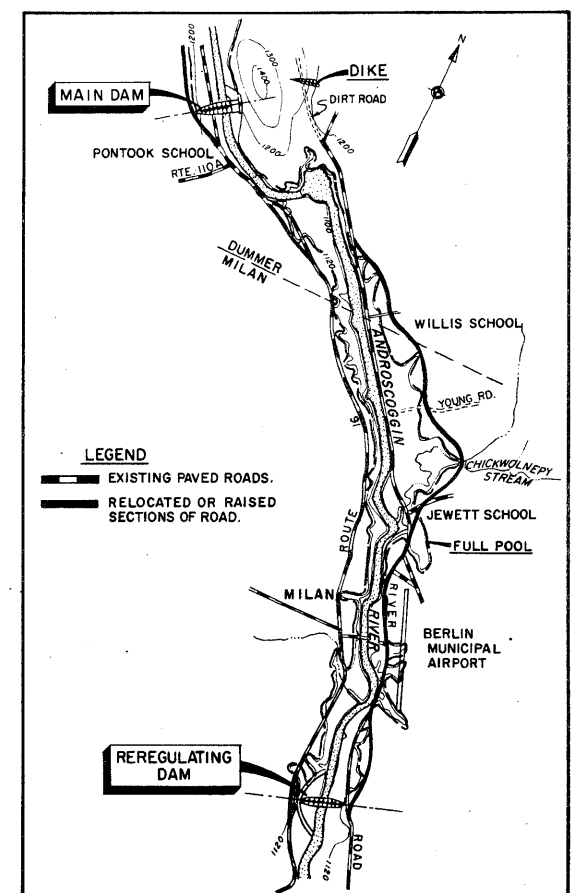
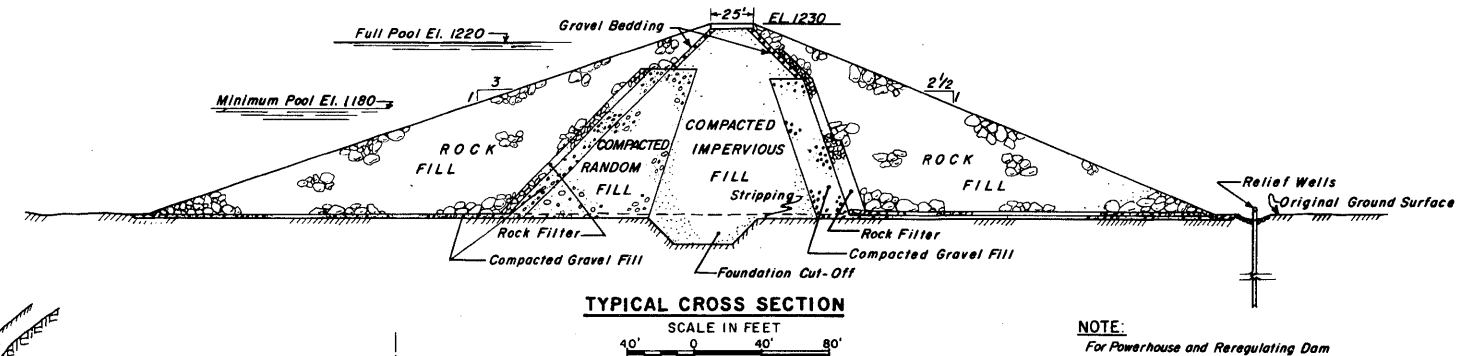
CONSTRUCTION PERIOD (years)	MULTIPLE-PURPOSE	ALTERNATIVE TWO			ALTERNATIVE SINGLE		
	PROJECT	PURPOSE PROJECTS			PURPOSE PROJECTS		
	F. C.	Power	F. C.	F. C.		Hydro	
	Power	Rec.	Rec.	Power	F. C.	Power	Rec.
	Rec.						
	(4)	(4)	(2)	(4)	(2)	(4)	(2)
<u>INVESTMENT & ANNUAL CHARGES</u>							
Construction Expenditure	73,300	73,300	27,900	72,200	7,100	72,200	27,900
Interest during Construction (3-1/8% $\times\frac{1}{2}\times$ Yrs)	4,581	4,581	872	4,513	222	4,513	872
Present worth of future additions for rec.	405	405	405	0	0	0	405
Investment	78,286	78,286	29,177	76,713	7,322	76,713	29,177
<u>Annual Charges</u>							
Interest and Amortization (0.03276)	2,565	2,565	956	2,513	240	2,513	956
Operation, Maintenance and Replacements	711	706	102	659	32	654	97
Loss of Taxes on Land	26	26	17	23	7	23	17
Net Loss to Fish & Wildlife	662	662	662	662	0	662	662
TOTAL ANNUAL CHARGES	3,964	3,959	1,737	3,857	279	3,852	1,732
<u>ALLOCATION OF ANNUAL CHARGES</u>	<u>F. C.</u>	<u>Power</u>	<u>Rec.</u>	<u>TOTAL</u>	<u>Alternative Pumped Storage Plant, Publicly Financed</u>		
Benefits	239	3,644	289	4,172	300,000 KW @ \$4.80 = \$1,440,000		
Alternative Project	279	1,994	1,732	4,005	115,000,000 KWH @ 0.0044 = 506,000		
Benefits Limited By Alt. Cost	239	1,994	289	2,522	12,000,000 KWH @ 0.004 = 48,000		
Separable Cost	5	2,227	107	2,339	\$1,994,000		
Remaining Benefits	234	negative	182		<u>Power Benefits</u>		
Allocation of Joint Use Costs					300,000 KW @ \$10.30 = \$3,090,000		
TOTAL ALLOCATION, ECONOMIC					115,000,000 KWH @ 0.0044 = 506,000		
					12,000,000 KWH @ 0.004 = 48,000		
					\$3,644,000		



MAIN DAM



DIKE

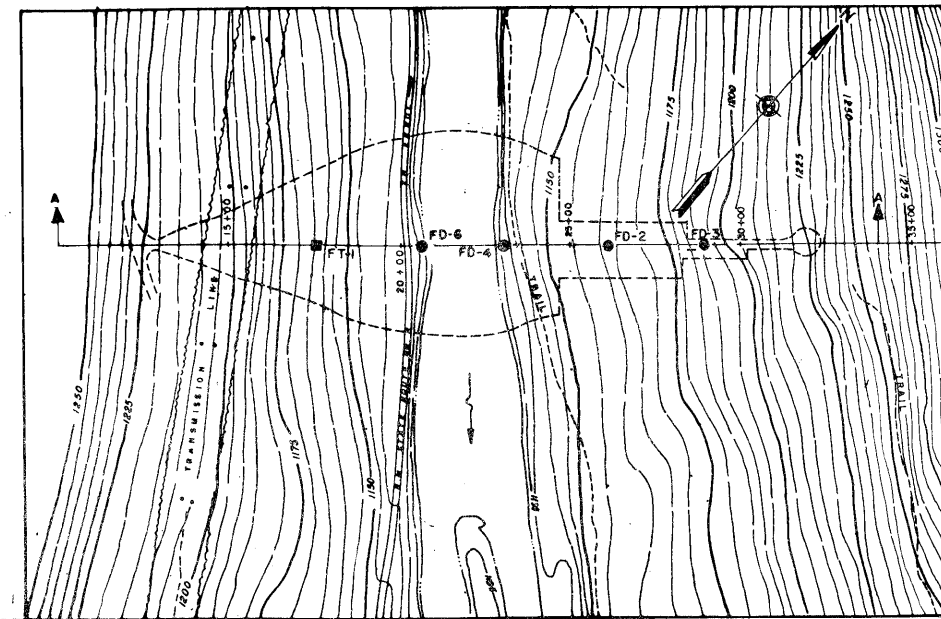


NOTE:
For Powerhouse and Reregulating Dam
See Plate No. 4.

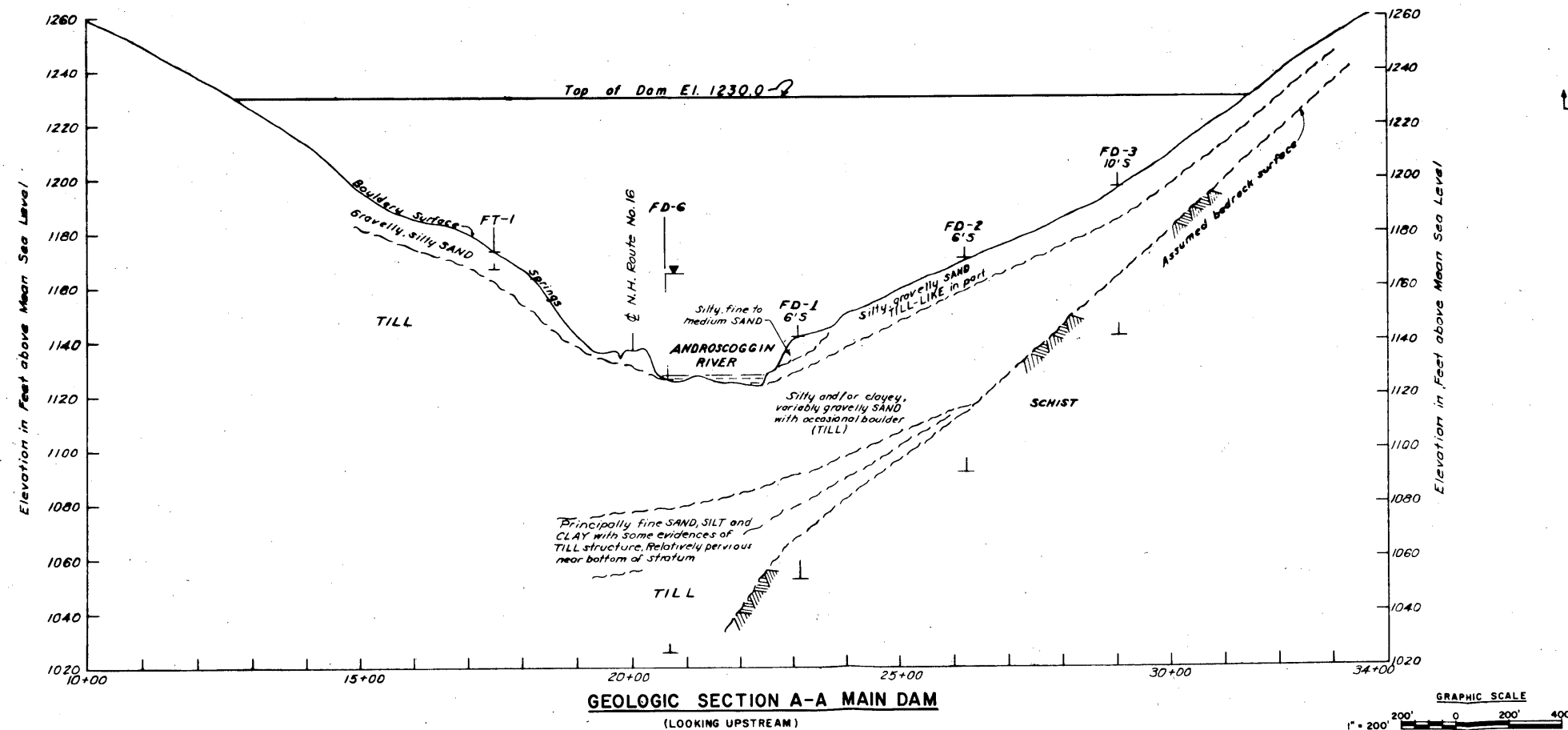
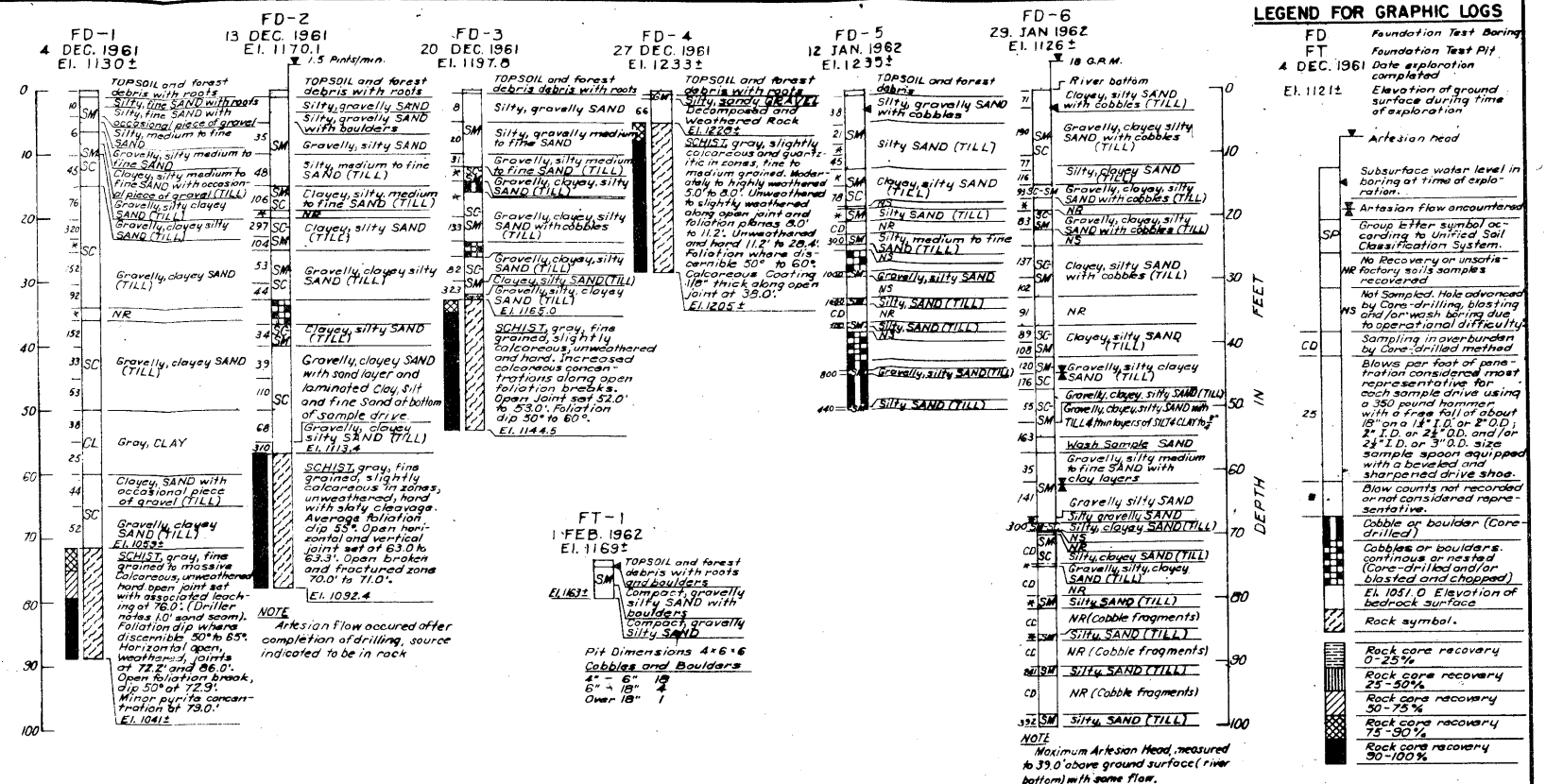
REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY NEW ENGLAND DIVISION - CORPS OF ENGINEERS WALTHAM, MASS.			
ANDROSCOGGIN RIVER BASIN, MAINE & N. H.			
PONTOOK PROJECT MAIN DAM & DIKE			
DR. BY J.T.S.	TR. BY G.H.D.	CR. BY D.C.	
ENGINEER			
PROJECT ENGINEER			
REVIEWED			
CHIEF PLANNING BRANCH			
APPROVAL RECOMMENDED			
APPROVED			DATE JUNE 1967
TO ACCOMPANY REPORT DATED: 22 JUNE 1967			DRAWING NUMBER SHEET 1 OF 2






PLAN
SCALE 1"=200'
(CONTOUR INTERVAL IS 5')



GEOLOGIC SECTION A-A MAIN DAM
(LOOKING UPSTREAM)

LEGEND FOR PLAN

- FD-1 Foundation Test Boring
 ■ FT-1 Foundation Test Pit
- 
 Location and Direction of View for Geologic Section

NOTES

Elevations refer to Mean Sea Level
Profile by NED Survey of Dec. 1961.
Plan from photogrammetry by Public Service Co. of
New Hampshire, 1965.

Borings FD-4 and FD-5, located at the dike site.

7/27/66 Top of Dam Elevation and Plan Changed

REVISION	DATE	DESCRIPTION	ACG.	BY

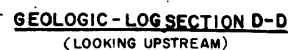
**U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS**

DES. BY DR. BY CR. BY R.C.G.R.D.B.R.C.G.	ANDROSCOGGIN RIVER BASIN, ME. & N.H. <h2 align="center">PONTOOK PROJECT</h2> <h3 align="center">PLAN AND RECORD OF EXPLORATIONS NO. 1</h3>
SUBMITTED <i>Hedley</i> CHIEF, GEOLOGY SECTION	
CHIEF, P & B BRANCH	
APPROVED _____ PROJECT ENGINEER	NEW HAMPSHIRE
APPROVED _____ CHIEF, ENGINEERING DIVISION	DRAWING NUMBER
CHIEF, P & B BRANCH	

SCALE AS SHOWN

**TO ACCOMPANY REPORT
DATED: 22 JUNE 1967**

SHEET 1 OF 2



1167	Some, Clay Rock
	DH 16
1181	Ground-Clay, Yellow Sand
1172	Medium Gray Sand
1167	Coarse Gray Sand
1156	Coarse Gray Sand, Clay
1147	Very Fine Sand and Clay
1146	Soft Broken Ledge
1121	Some 25' Diamond-Drilled

7/27/66		REC		BY	
REVISION		DATE		DESCRIPTION	
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS					
DES. BY R.C.G.	DR. BY R.A.W.	CK. BY R.C.G.	ANDROSCOGGIN RIVER BASIN, ME. & N.H. PONTOOK PROJECT PLAN AND RECORD OF EXPLORATIONS NO. 2		
SUBMITTED <i>Bo. Parker</i> CHIEF, GEOLOGY SECTION			NEW HAMPSHIRE APPROVED		
REVIEWED PROJECT ENGINEER			DATE <u>JUNE 1967</u>		
APPROVED CHIEF, F & M BRANCH			CHIEF, ENGINEERING DIVISION		
TO ACCOMPANY REPORT DATED: 22 JUNE 1967			SCALE AS SHOWN DRAWING NUMBER		
			SHEET 2 OF 2		

APPENDIX F
POWER STUDIES

APPENDIX F
POWER STUDIES

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APPENDIX F

POWER STUDIES

1. GENERAL

Detailed power studies were made of two potential hydroelectric developments: at Pontook on the Androscoggin River above Berlin, and at Hale on the Swift River above Rumford. Flows at the two sites were determined from flow records at nearby U.S.G.S. gaging stations and adjusted on a drainage area relationship to the specific site under study. For Pontook, observed flows and natural flows from the six lakes above Errol, were based on records at the Errol gage (drainage area 1,045 square miles) located 19 miles upstream of the dam site and observed flows from records at the Gorham gage (drainage area 1,363 square miles) located 15 miles downstream of the dam site. A gage on the Swift River near Roxbury (drainage area 95.8 square miles), 3 miles upstream of the Hale site, provided data for the Hale study. Stream flow records are available for the Errol gage since January 1905, for the Gorham gage since October 1913, and for the Roxbury gage since June 1929. Mass curves of observed and natural flows were developed through the critical low flow periods of record for the respective sites. For Pontook, an electronic computer program was developed to determine the storage required for various dependable flows and to establish the system power rule curve. Upon advice from the Federal Power Commission, installations were based on a dependable capacity factor of approximately 5 percent. The methodology used in sizing and estimating the potential hydroelectric installations at the two projects was similar and is described in some detail in this appendix for Pontook.

2. PONTOOK PROJECT

a. Main Dam.

(1) At Pontook, the full pool elevation of 1220 feet, msl, is limited by improvements in the town of Errol at the upstream end of the reservoir. Flood control studies determined that storage space is required during the spring and fall but that during the summer and winter, the pool may be kept at full elevation 1220 without significantly affecting the flood control effectiveness of the project. It was further determined that the maximum drawdown of the power pool should not exceed 40 percent thus establishing the minimum power pool at elevation 1180. Storage between elevation 1180 and 1220 amounts to 207,000 acre-feet which, together with the 661,000 acre-feet in the upstream reservoirs, would maintain a dependable flow of 1,724 cfs. A mass diagram illustrating use of this storage during the critical low flow period of 1940-1943 is shown on Plate F-1. Below elevation 1180 would be dead storage of 31,000 acre-feet. Stored flood waters would normally be released

through the turbines which can empty the flood pool as rapidly as downstream channel capacities permit.

(2) In determining the dependable flow of 1,724 cfs at Pontook, it was assumed that, if the upstream storage in the reservoirs above Errol could be regulated in conjunction with the storage at Pontook to improve the downstream flows, the resulting increase in flows would be acceptable to the downstream water users without compensation for use of this storage for flood control purposes.

(3) The Union Water Power Company attempts to regulate Errol and upstream reservoirs so that flows at Berlin will be between a minimum of 1,550 cfs and a maximum of 2,500 cfs. In this report, the adopted regulation yields discharges varying from a minimum of 1,724 cfs to a maximum of 2,500 cfs except that this maximum discharge is exceeded under certain conditions as described in paragraph (5) (a) following. For the period of record 1938-1963, the average of all monthly observed flows at Pontook, based on readings at the Errol and Gorham gages, adjusted to the Pontook drainage area (excluding amounts in excess of 2,500 cfs which are not usable) was 1,958 cfs. For the same period, the comparable value in the adopted regulation is 2,085 cfs, an increase of 127 cfs. This increased flow would provide an average annual energy increase of 12,000,000 KWH to 10 existing downstream power plants with a total net head of 214 feet.

(4) A system rule curve was developed for the entire 868,000 acre-feet of storage. This area was separated into four sub-storage areas - Richardson Lakes and above, Aziscohos, Umbagog and Pontook - and rule curves were developed for each sub-area. Pertinent data relative to these sub-storage areas is given in the following table:

Sub-storage Area	D. A. (sq. mi.)	Usable Storage			Draw- down (feet)
		Ac. -ft.	MSF	Inches	
Kennebago	101	16,600	275	3.1	7.5
Rangeley	99	30,700	510	5.8	4.0
Mooselookmeguntic	182	192,100	3,180	19.8	12.0
Richardsons	90	130,700	2,165	27.2	17.5
Sub-total or (Average)	472	370,100	6,130	(14.7)	-
Aziscohos	214	220,200	3,650	19.3	45.0
Umbagog	359	70,700	1,170	3.7	9.5
Sub-total or (Average)	1,045	661,000	10,950	(11.9)	-
Pontook	170	207,000	3,430	22.8	40.0
Total or (Average)	1,215	868,000	14,380	(13.4)	-

(5) Rule curves shown on Plate F-2 were developed as follows:

(a) For the system rule curve, two limits were established - a flood control rule curve as the upper limit and a power rule curve as the lower limit. The flood control rule curve makes available flood control storage for the 1215 square mile drainage area varying from zero (i. e., all pools full) in the summer months to at least 4.4 inches of runoff in the spring. For the power rule curve, determinations were made of the minimum storages required the first of each month to maintain a minimum dependable flow of 1,724 cfs at Pontook. This curve would permit the system to be drawn down to such a level on the first of April that flood control storage could be increased to approximately 8 inches of runoff from the 1,215 square miles. Based on late winter and early spring snow surveys in the drainage basin, discharges may be increased up to a maximum of 2,500 cfs to assure that the flood storage space would be available. Discharges would exceed this maximum to keep the total storage from rising above the flood control rule curve.

(b) The Pontook rule curve maintains full pool during July and during the winter months; during other periods, the monthly content of the pool is varied so as to provide storage capacity of at least 10.9 inches in the spring and 4.1 inches in the fall. The flow regulation analyzed for this report maintains the pool as close as possible to the rule curve.

(c) The rule curves for the area at and above the Richardson Lakes, the area above the Aziscohos dam, and the area above the Errol dam each provides for its share of the system flood control storage generally in proportion to the respective drainage areas.

(6) Regulation of the March 1936 flood, following the rule curves, proved satisfactory and is discussed in detail in paragraph 10h (1) of Appendix B. It was assumed that, when the storage was below the rule curves, water would be drawn from each reservoir in proportion to its net drainage area. The only exception was Umbagog reservoir which contains 70,700 acre-feet of storage. This storage was always used before utilizing storage from the remaining areas and filled only after the other storage areas had been filled.

(7) After deducting losses due to leakage and seepage, a December usable dependable flow of about 1,513 cfs was obtained. Operation of the reservoir for power production would result in a maximum gross head of 99 feet, an average net head of 93 feet, a minimum net December head during the critical low flow period of 97 feet, and a minimum net head of 57 feet.

(8) Three vertical Kaplan turbines, each capable of developing 140,000 horsepower at full net head, would be direct-connected to three 100,000 KW generators for a total installation of 300,000 KW, all of which would be dependable at the time of the peak (December) load. The plant would have an average annual capacity factor of 6.1 percent and a minimum December load factor of 5.8 percent on a 5-day per week basis. Average annual energy would amount to 115,000,000 KWH.

b. Reregulating Dam. Storage presently available in the six reservoirs above the Errol dam totals 661,000 acre-feet which is operated to provide uniform dependable flow at Berlin and points downstream for the benefit of paper mills and other water users. Surges caused by the peaking operation of the Pontook power station would be automatically reregulated by a dam located about $6\frac{1}{2}$ miles below the main dam. This dam would have a reservoir having a total capacity of 16,300 acre-feet at elevation 1121, the normal tailwater elevation at the powerhouse tailrace. A usable capacity of 15,000 acre-feet would permit reregulation of the Pontook discharges to uniform flow conditions up to 2,500 cfs. Flows would be released through the tainter gates at the spillway.

c. Betterment of Downstream Flow Conditions. Average monthly flow records at the Gorham gage show that, of the 312 months studied between 1938 and 1963, 22 months showed flows less than the minimum of 1,550 cfs which is desired by the water users on the river, the lowest flow being 1,257 cfs. Maximum releases which are considered usable by existing downstream plants are estimated to be 2,500 cfs. Based on observed outflows from the Errol dam and considering amounts of flows in excess of 2,500 cfs to be wasted, usable flows at the Pontook site averaged 1,958 cfs over the period studied. With the regulation afforded by Pontook, average usable flows would be 2,085 cfs, an increase of 127 cfs. There are about 30 existing hydroelectric plants downstream of Pontook. The varied ownership and types of plants make it difficult to determine the exact amount of additional power that could be generated as a result of Pontook regulation. An approximation of downstream benefits was derived on the following basis:

(1) Seventy percent of the increased flow would be used annually;

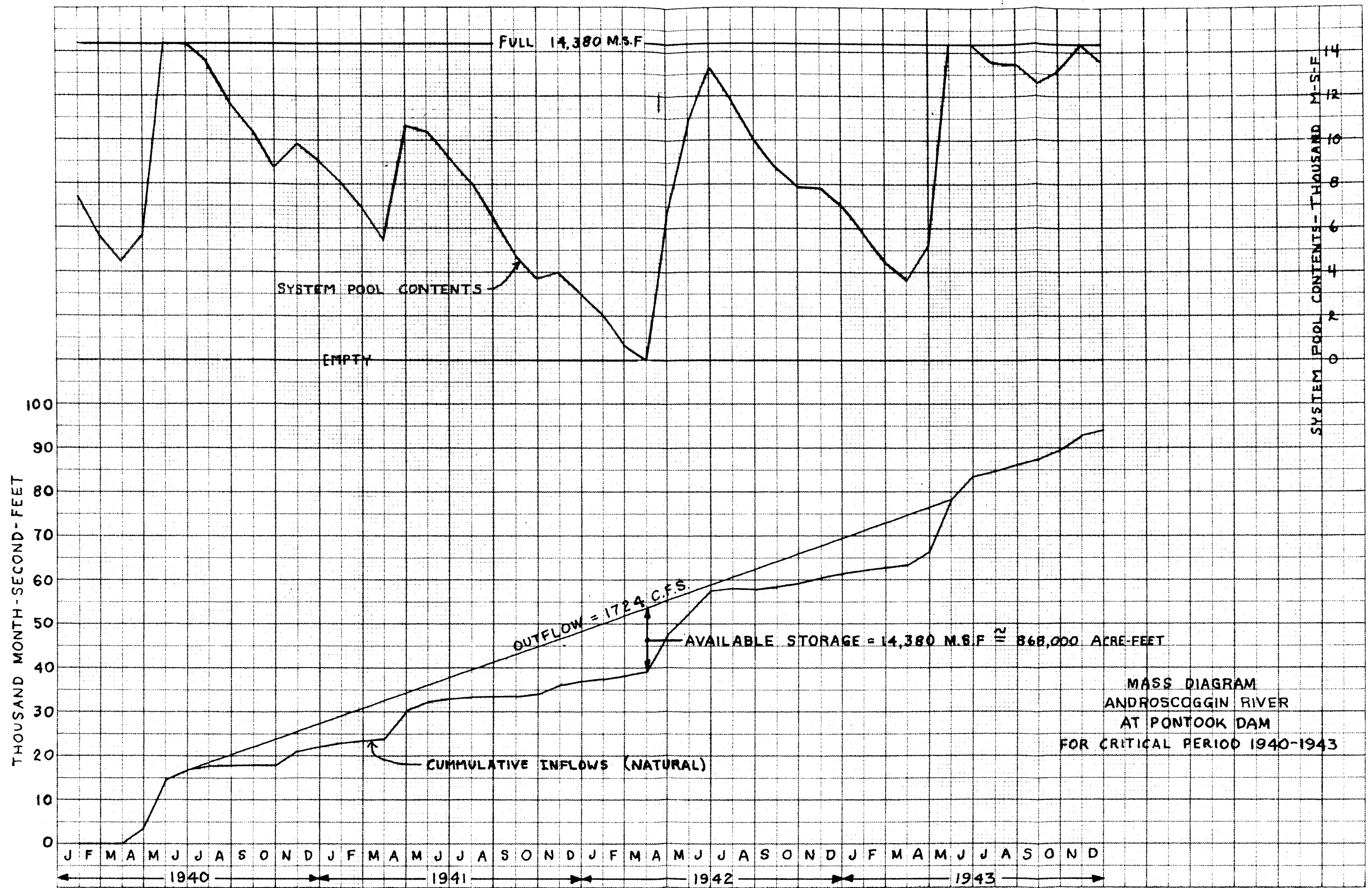
(2) Only those plants currently operating at less than 70 percent annual capacity factor would benefit.

Ten plants, with a total net head of 214 feet, would fall within these limits. The total average annual increase at these 10 plants is estimated at 12,000,000 KWH.

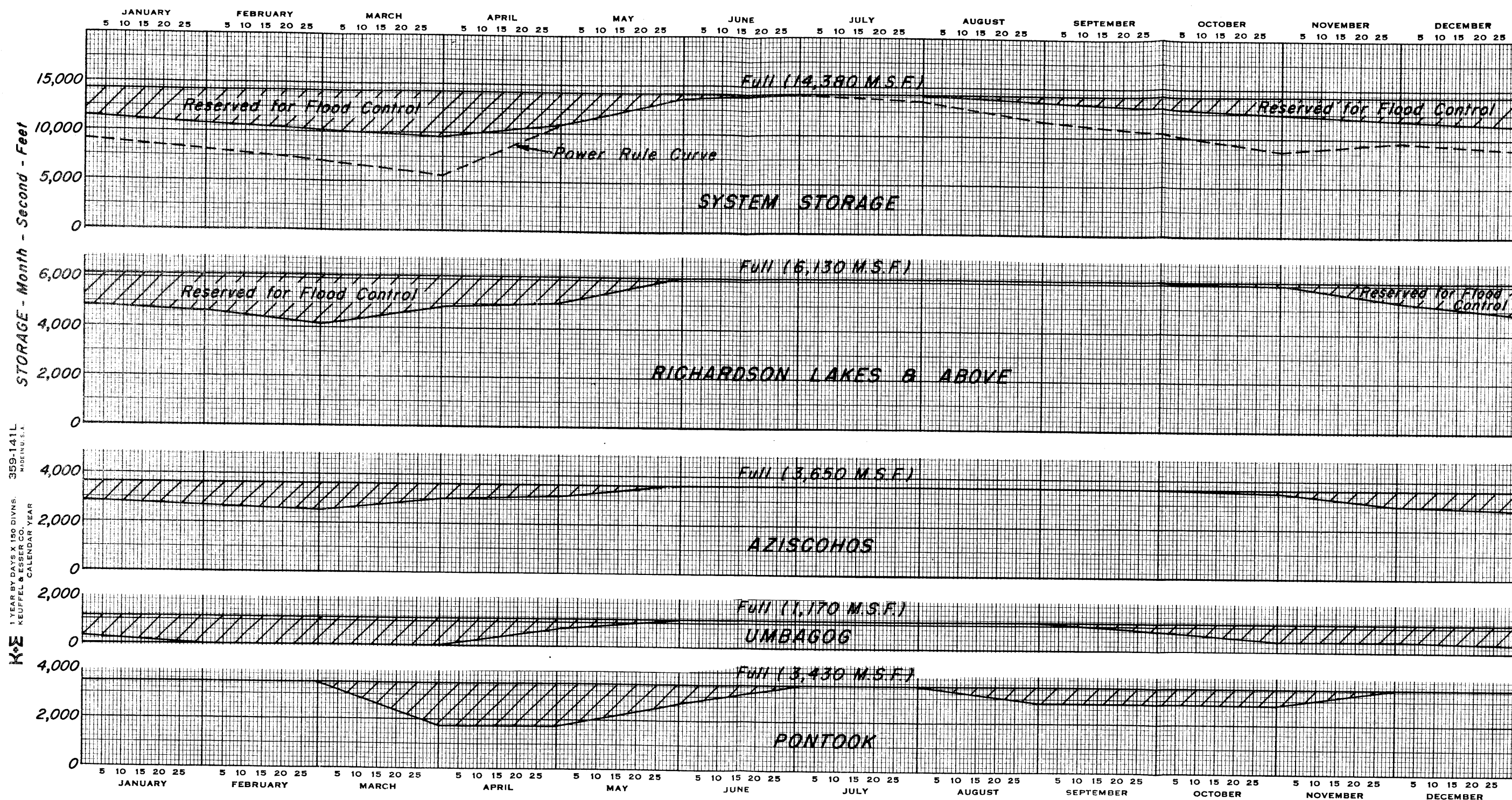
Plans of the project powerhouse and installation are shown on Plate E-2 of Appendix E.

3. PUMPED STORAGE POTENTIAL

Consideration was given to use of reversible pump-turbines, with the pool created by the reregulating dam being used as an afterbay. At the present state of technology and costs of reversible units for the comparatively low head involved as an integral pumped storage development at this site, the cost of including such units is greater than the benefits which would be realized on a comparably-financed basis.



MASS DIAGRAM
ANDROSCOGGIN RIVER
AT PONTOOK DAM
FOR CRITICAL PERIOD 1940-1943



OPERATING RULE CURVES

PLATE F-2

APPENDIX G
RECREATIONAL DEVELOPMENT

APPENDIX G

RECREATIONAL DEVELOPMENT

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APPENDIX G

RECREATIONAL DEVELOPMENT

1. INTRODUCTION

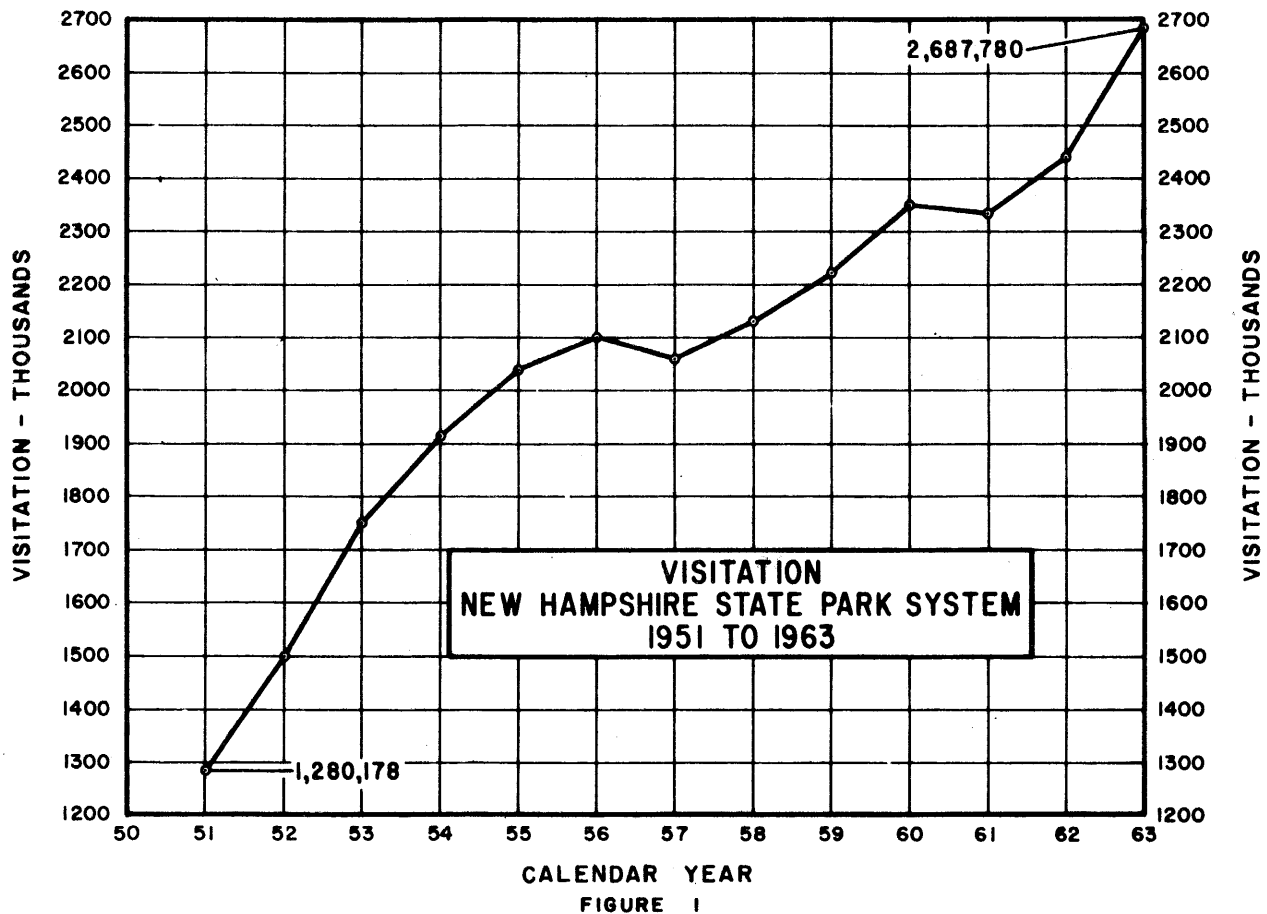
The Pontook Dam and Reservoir project, located on the Androscoggin River in the White Mountain area of northern New Hampshire, is favorable for recreational development. The 2,000-foot long dam, with a height of 106 feet above stream bed, would impound a 7,500-acre lake of crystal-clear Androscoggin River water extending 16 miles up the river valley. Tremendous recreational use potential in this project results from the high incidence of people in thickly populated areas of New England and adjoining regions who would vacation or visit here. Details of a development for recreation, including economic factors, are described in this Appendix.

2. DEMAND FOR RECREATION

a. General. The demand for outdoor recreational opportunities in New England and the northeastern states is high and is continuing to rise. The Outdoor Recreation Resources Review Commission study report number 8, "Potential New Sites for Outdoor Recreation in the Northeast" states "Population, income, leisure time, mobility and length of life statistics indicate that demand for outdoor recreation will rise." The most dominant factor in the demand for recreational facilities is the high density of population, with New England having 6 percent of the nation's population and the northeastern states having 25 percent. This becomes most significant when one considers that New England covers only 2 percent of the area of the continental United States and the Northeastern States only 5 percent.

b. Use of Existing Facilities. Development of recreational facilities at reservoirs constructed by the Corps of Engineers has provided added opportunities for the outdoor recreation seeker in New England. Attendance increased from 470,000 to 2,860,000 between 1960 and 1963 at these reservoirs and the Cape Cod Canal. It is noteworthy that facilities at 16 projects opened during this period were put to intensive use immediately on being made available to the public.

Use of park facilities offered in New Hampshire has more than doubled since 1951 as shown in Figure 1. In 1963, the attendance was nearly 2.7 million at State Parks designed for 1.5 million users.



c. Demand for Water-Based Recreation. Water-based recreation is the most desired outdoor activity. The Outdoor Recreation Resources Review Commission's "National Recreational Survey" reports that 44 percent of the U. S. population prefers water-based recreation activities over any others and that recreation on land such as camping and picnicking is enhanced by being near water.

The primary use of the White Mountains is for sight-seeing, hunting, fishing, hiking, and camping. There is also a strong inherent demand by the using public for water-based recreation in view of the significant lack of publicly-oriented lake-type resources in the region.

3. RECREATIONAL POTENTIAL OF THE PROJECT

a. Potential Public Use. In order to determine the potential public use of the Pontook reservoir project, many factors were investigated and their effect and relation to public use of the project determined. The basic factors which would determine the development of the reservoir are the inherent use potential in the people who would be expected to create use pressure and the quality and quantity of resources which the project can tap. The natural attractions of the area would constitute an important resource.

b. White Mountain Area.

(1) General. The White Mountain region constitutes the greatest inland tourist attraction in New England. The history of the recreational use of the White Mountains includes the beginnings of outdoor recreation in America. Mount Washington (6,288 feet, m.s.l.) was first climbed in 1642 by Darby Field only 22 years after the landing of the Pilgrims. From that time on, the area has been a favorite attraction to millions of recreation seekers.

(2) Scenic Interest. From the peak of Mount Washington on a clear day, one can see a panorama of ranges and valleys extending for nearly 100 miles and taking in landmarks in Maine, Vermont, and Massachusetts. The peak dominates this area of New Hampshire, a region filled with rugged scenic notches carved between the mountains, gorges marked by forested slopes laced with cascading streams, and outstanding natural rock formations. Among well known features are "the Flume"; Crawford, Pinkham and Franconia Notches; the "Pool", and "Basin", filled with crystal clear water; picturesque Glen Ellis Falls and the Crystal Cascade; and - most famous, - the Old Man of the Mountains, lifting its face to the ages.

(3) Recreational Resources. The most significant recreation resource in the region is the White Mountain National Forest. Two State parks within the limits of this National resource and within 50 miles of the proposed project present the greatest attraction to the recreation seekers. These are Crawford Notch and Franconia Notch which together received over 95 percent of the 1963 total visitor-day use of all the State parks within a 50-mile radius of the project.

(4) Types of Activities. Since the main activities in the White Mountain area are viewing its scenic splendor, hiking, camping, and fishing, the area has long been an attraction, especially to the outdoor type of person who can roam the mountain tracts for days, stopping overnight at campsites, shelters, and cabins. The fishermen can find in the rivers, streams and cascading waterfalls, excellent trout fishing. However, what the general recreation seeker wants and cannot find is water suitable for swimming and boating. Thus, the greatest attraction to most outdoor enthusiasts is lacking in the area.

(5) Tourist and Vacation Trends. The scenic charm of the White Mountains is a perennial lure, alike to the sophisticated or the work-weary visitor. It has supplied the Nation since the early seventeenth century with opportunities for recreation. The area is well developed with motels, hotels, and cottages for transient and vacation use. Surveys have shown that visitation to the area has practically doubled in the past decade.

(6) Existing Park and Recreational Areas. Within a 50-mile radius of the project, there are 13 developed public recreation areas, exclusive of the White Mountain National Forest, offering public-use facilities. They include approximately 20,000 acres of land. Eight of the areas offer bathing facilities, but on a small scale due to lack of shore front ownership. The only public access to a sizeable water surface at any of the recreation areas is at the 469-acre Maidstone State Forest on the shore of the 1,500-acre Maidstone Lake in Vermont.

The largest water area open for public use is the New England Power Company's Moore Reservoir. The reservoir has approximately 4,000 acres of water surface and facilities are available for public boat launching and picnicking on adjacent lands. No bathing facility is offered.

None of the six Corps of Engineers' flood control reservoirs in New Hampshire are within the 50-mile zone of influence. Two of them, the recently completed Hopkinton-Everett Reservoir and the Otter Brook Reservoir, completed in 1961, offer recreational developments. Facilities are provided at both for picnicking, swimming, boating and fishing.

The largest tourist attraction offering public-use facilities within a 50-mile radius of the project is the White Mountain National Forest. Eighty percent or approximately 550,000 acres of this National reserve lie within this radius. The main attraction of this area is its natural scenic beauty and developed camp grounds and hiking trails. There is only one developed swimming area and no water area large enough or having access facilities for boating. Table G-1 lists the recreation areas and facilities offered.

d. Suitability of Reservoir for Recreational Development. The Pontook Reservoir could be adapted for recreational development. The permanent pool would create the second largest water area in New Hampshire, surpassed in size only by Lake Winnepesaukee. The shoreline of the permanent pool would have adequate slopes to support beach development, requiring only clearing and placing of a sand blanket by way of construction work. The adjacent land is highly diverse. It is well forested and readily adaptable to day use and overnight camping development. The mountain streams located in the area add to the aesthetic value of the land as well as supply a source of water for the recreation area. There is adequate land area composed of gently sloped rolling hills to support development. There is also the steep rising Sugar Hill which rises 450 feet above the 7,500-acre lake and offers ideal terrain for hiking tracts with a panoramic view of the lake and the surrounding mountain side. In general, the area around the Pontook Reservoir exhibits spectacular scenery and provides a wide variety of recreational possibilities.

e. Climate. The air in the White Mountains area is dry and clear and a favorite for sufferers of hay fever. In 52 years of record, the minimum and maximum temperatures in Berlin, New Hampshire have been -44°F and plus 100°F. The summers are pleasant with an average temperature around 70°F. Average precipitation in Berlin is 40 inches with an average winter snowfall amounting to 100 inches.

f. Fish and Wildlife Resources. Fish and wildlife resources of the project are discussed in Appendix H of this report.

g. Accessibility. The Pontook Reservoir site is easily accessible by east-west U. S. Route 2 and north-south State Route 16. Both roads are paved two- and three-lane highways. The driving distance from Boston, Massachusetts is 180 miles or approximately four hours leisurely driving time. It is within seven hours driving time of almost all of New England and New York City or within the average driving range which would be considered for a vacation trip.

TABLE G-1

EXISTING PUBLIC PARK AND RECREATION AREAS WITHIN
50 MILES OF THE PONTTOK RESERVOIR

Facilities Offered

	Bathing	Boating	Camping	Fishing	Hiking	Picnicking	Scenic Road	Skiing	Land Area (acres)
<u>NEW HAMPSHIRE</u>									
Milan Hill S.P.			X			X			127
Mount Prospect S.P.						X	X		430
Moose Brook S.P.	X		X	X	X	X			755
Forest Lake S.P.	X	X		X		X			420
Crawford Notch S.P.			X	X	X	X	X		5950
Franconia Notch S.P.							X	X	6275
Echo Lake	X			X	X	X			
Flume Gorge					X	X			
Lafayette Campground			X	X	X	X			
Profile Lake				X	X	X			
Echo Lake S. P.	X				X	X	X		405
<u>VERMONT</u>									
Brighton S. P.	X		X	X	X	X			59
Darling S.P.			X		X	X		X	1705
Maidstone S.F.	X	X	X	X	X	X			469
<u>NEW HAMPSHIRE-VERMONT</u>									
Moore Reservoir		X		X	X	X			
<u>WHITE MOUNTAIN NATIONAL FOREST</u>									
C. L. Graham Wangan Ground					X	X	X		
Cold River Campground			X	X	X	X	X		
Covered Bridge Campground			X	X	X	X	X		
Dolly Copp Campground			X	X	X	X	X		
Dugway Campground			X	X	X	X	X		
Glen Ellis Falls Scenic Area					X	X	X		
Long Pond Camp			X	X		X			
Lower Falls Picnic Area				X		X	X		
Oliverian Campground			X	X	X	X			
Passaconaway Campground			X	X	X	X	X		
Rocky Gorge Scenic Area				X	X	X	X		

TABLE G-1 (cont'd.)

EXISTING PUBLIC PARK AND RECREATION AREAS WITHIN
50 MILES OF THE PONTOK RESERVOIR

	<u>Facilities Offered</u>								
	Bathing	Boating	Camping	Fishing	Hiking	Picnicking	Scenic Road	Skiing	Area (acres)
<u>WHITE MOUNTAIN NATIONAL FOREST (cont.)</u>									
Russell Pond Campground		X	X	X	X		X		
Sawyer Rock Picnic Area				X		X	X		
South Pond Recreation Area	X			X	X	X			
Sugarloaf Campground			X	X	X	X			
Tuckerman Ravine			X		X			X	
Waterville Campground			X	X	X	X			
White Ledge Campground			X		X	X			
Wild River Campground			X	X	X	X			
Wildwood Campground			X	X		X			
Zealand Campground			X	X	X	X			
<u>MAINE</u>									
Mount Blue S.P.	X		X	X	X	X	X		1284

NOTE: S.F. - State Forest

S.P. - State Park

4. ANTICIPATED PROJECT USE

a. The Desirability of the Project. The water area offered by the project would be the major attraction of the Pontook Reservoir. The 7,500-acre water surface which would be available during the summer use season would provide opportunities for swimming, boating, water skiing, and fishing. It would also offer an attraction for such land-oriented activities as picnicking, hiking, and camping. Other leisurely uses such as walking by the water, bird watching, and sightseeing would receive increased usage. The area is presently hunted over but such use would be considerably reduced with the project. (See Appendix H).

b. Population Potential. The main factor determining the recreational development of the reservoir project is the use potential in the population that would be expected to create use pressure on the project. To determine the use potential, it was necessary to determine the present and potential population, employment, income, and available leisure time of the people and the effect these factors would have on their desires to participate in the recreational opportunities offered by the project.

(1) Population. Within a 15-mile zone of influence of the project, there are some 21,000 inhabitants. The one-hundred mile zone of influence encompasses some 525,000 people, and the 200-mile zone over 10 million.

(2) Income. The median income of families within a 15-mile radius of Pontook Reservoir in 1960 was \$5,200 with 76 percent of the families with incomes between \$3,000 and \$10,000 and eight percent with incomes of \$10,000 or over. Median family incomes of the entire zone of influence were higher largely because of the effect of Massachusetts, Connecticut and New York. The median family income of the entire zone was about \$6,100 with 70 percent of the families with incomes between \$3,000 and \$10,000 and 16 percent with incomes of \$10,000, or over. (1)

Participation in outdoor activities increases with income, the increase being the sharpest at about \$3,000 a year; from this level on, participation steadily increases reaching a maximum in the \$7,500-\$10,000 bracket then declining slightly thereafter. (2)

(1) U.S. Dept. of Commerce, Bureau of the Census

(2) Outdoor Recreational Resources Review Commission, Main Report, 1962

(3) Education. Of all persons 25 years old and over within the zone of influence of the Pontook Reservoir, the median school years completed were over 11. ⁽¹⁾ Education affects participation much as does income; the more education adults have, the more active they are likely to be. ⁽²⁾ The percentage of persons participating in outdoor activities is higher among the group with more than three years of high school than among those with less education.

(4) Employment. Occupation has a considerable influence on participation in outdoor activities. The greatest participation was by the non-labor force. Among occupations, professional people enjoy the most recreation and farm workers the least. Within the Pontook zone of influence, about 60 percent of the population belonged to the non-labor force. Of the employed labor force, about 42 percent were in white collar occupations and about 37 percent were in manufacturing industries. ⁽¹⁾ About two percent of total population were of the rural farm type for the entire zone and five percent for the immediate area.

(5) Leisure Time. In special studies conducted by the Bureau of Labor, statistics confirm the trend toward a shorter than 40-hour week. All figures point to a continuation of this trend into the future. More time will be available to participate in outdoor recreation, and this increase will bring greater pressure upon existing facilities. It will also increase the demand for expansion of existing facilities and the development of new recreation facilities. Greater opportunity is urgently needed in the densely-populated New England area to meet the mounting needs and demands of the majority of the residents who are primarily skilled wage earners. Some of the demand can be satisfied in the after-work and weekend hours at the Pontook Reservoir.

c. The Recreational Market. The source of the recreational market had to be considered in order to plan project development. The major portion of the recreational market of the Pontook Reservoir is expected to be comprised of visitors from New Hampshire and Massachusetts with visitors from New York having somewhat less significance. Rounding out the market will be visitors from Canada, Vermont, Maine, Connecticut, Rhode Island, New York, New Jersey and other parts of the United States. This assumption is predicated on 1943 and 1963 surveys by the State of New Hampshire to determine the origin of visitors to their State Park System. The 1963 survey shows that approximately 78 percent of visitor-days was non-resident. This indicates an increase of 23 percent since 1943. Results of these surveys, shown in Table G-2, are based on a sampling of 10 percent of day users and 25 percent of campers.

(1) Ibid

(2) Ibid

TABLE G-2

SOURCE OF VISITORS BY STATEPercentage of Total Visitor-Days

<u>State</u>	<u>1943 Study</u>	<u>1963 Study</u>
Maine	2	2
New Hampshire	45	22
Vermont	1	1
Massachusetts	32	39
Rhode Island	2	3
Connecticut	3	5
New York	7	11
New Jersey	5	3
Other (Includes Canada)	3	14

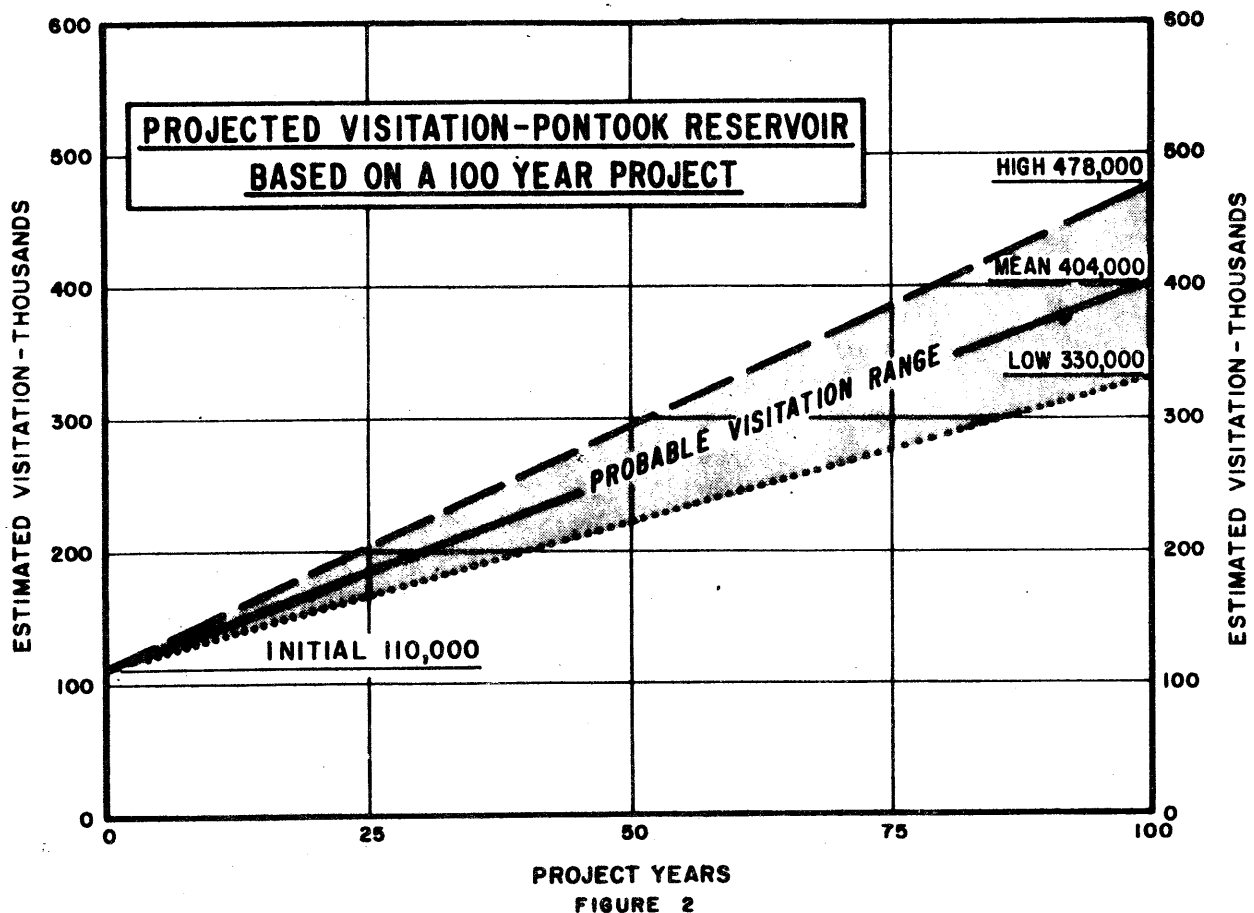
The more recent survey shows that 61 percent of the visitors come from Massachusetts and New Hampshire. It is assumed that the source of the majority of Massachusetts visitor-days is people in eastern Massachusetts, including the 2.6 million people residing in the Boston Metropolitan area. A cross-sectional analyses of the income, education, employment, and leisure time of the people of Massachusetts and New Hampshire reveal that the majority of these are within the group which desires to participate in public outdoor recreational activities.

Another important factor which would influence use of the Pontook Reservoir is the high number of seasonal residents in New Hampshire and especially in the White Mountain Area. According to 1960 census figures, the year-round population of New Hampshire is 607,000 with an increase of 214,000 in the summer season. There are 55,000 year-round residents and approximately 30,000 additional residents in the summer season within a 50-mile radius of the project in New Hampshire, including approximately 80 percent of the White Mountain National Forest. In the period 1957 to 1960, summer season residency increased 87 percent in New Hampshire.

d. Estimated Visitor-Days. The Pontook Reservoir is expected to exert an influence on the recreational desires of a large area of the Northeast including New England, New York and New Jersey as well as the Province of Quebec, Canada. It is assumed that 30 percent of the visitor

days would come from surrounding communities within a 50-mile radius of influence and 25 percent would come from the zone of influence between 50 and 100 miles from the project. Based on recent surveys by the State of New Hampshire, it is also reasonable to predict that 40 percent of the visitor-days would come from the Metropolitan areas in Massachusetts, Connecticut, New York, New Jersey, and Quebec, Canada, with the remaining five percent coming from various other locations.

It is conservatively estimated that visitors from the above areas would amount to 110,000 visitor-days upon completion of recreational development of the project. Over the 100-year life of the project the visitor-days would rise, as shown in Figure 2, and reach 404,000 annual visitor-days by project year 100.



These figures represent visitors using developed recreation facilities and do not include sightseers to view the project or hunters and fishermen. The project is expected to attract approximately 200,000 sightseer visitor-days annually. The Pontook development would not compete with the land-based attractions of the White Mountain area but would supplement them by offering to the visiting public a water area of significant size presently lacking in the area.

e. Basis of Estimated Visitation.

(1) The most prominent factors affecting the recreational use evaluation of the Pontook Reservoir are as follows:

(a) Population. The project area is expected to be used by the population residing within 200 miles of the project. This is predicated on surveys made by the State of New Hampshire at the Franconia Notch State Park (in close proximity to the project) which revealed that the majority of visitation to the area came from within the 200-mile zone, with the largest percentage from Massachusetts. The population within this zone is over 10 million people.

(b) Proximity of the project to population centers. The largest population center in New England, the Metropolitan Boston Area, is within a 4-hour drive of the project. This center will have the greatest effect on recreational use of the project.

(c) Characteristics of population. The income, education, employment, and leisure time characteristics of the population within the 200-mile zone of influence are generally representative of the type person who heavily uses outdoor recreation areas.

(d) Suitability of project for recreational use. The 7,500-acre water surface created by the project would be a most welcome addition to the popular White Mountain Recreation Area which has no significant lake-type water resource. The public lands of the project are well suited for economical construction of recreation facilities. Land areas are gently rolling to steep and are well forested.

(e) Existing recreation areas in project vicinity. There are many developed areas in the vicinity of the project in and adjacent to the White Mountain National Forest reserve. However, there is no significant publicly-owned water surface for water-based recreation.

(2) The project is expected to receive approximately 110,000 annual visitors upon completion which is equal to approximately 1% of the population within the 200-mile zone of influence. In addition, there will be 200,000 sight-seers. These figures do not include hunters and fishermen.

(3) The nearest significant park development to the project is the Crawford Notch State Park which experienced a 1964 visitation of 330,000. The Pontook project would be an hour's driving time farther from the Boston area than Crawford Notch State Park. Although the Pontook project would have a water-based recreation attraction not existing at Crawford Notch, it is expected that the visitation will be less due to the remoteness of the project. Also, the recreation season at the Pontook area would be shorter than at Crawford Notch. The Crawford Notch area has a recreation season extending into the end of the fall foliage season in October due to its unusual scenic attractions. It is assumed that the Pontook area would receive at least one-third of the visitation that the Crawford Notch State Park receives or 110,000 annual visitors.

(4) Future projections of visitation, which are shown in figure 2, page G-11, are based on population projections for the New England area contained in the ORRRC Study Report No. 3

(5) Recreational evaluation is further substantiated by a 1962 report on the possible expansion of the Echo Lake State Park in North Conway, New Hampshire by Charles T. Main, Inc., Boston, Massachusetts. The report proposed the construction of a dam on the Saco River which would impound 1800 acres of water with attendant facilities to accommodate approximately 175,000 annual visitors. The Pontook area would offer a physically more attractive project. The Echo Lake project has not been constructed because of local opposition.

5. DEVELOPMENT PLAN

a. General. The area chosen for initial and future recreational use is shown on Plate G-1. This is the area considered to be most practical in terms of terrain, cover, access, and economical development. The development layout shown is schematic in nature and depicts a typical layout.

The number of facilities provided was determined on a design load basis. Design load was determined by use of the National Park Service formula:

$$D. L. = \frac{1}{14} \times (AV \times .80) \times .60 \times 1.5$$

in which:

- D. L. = Design Load
- AV = Annual Visitation
- 1/14 = Number of summer Sundays, inversely
- .80 = Percent of attendance that will use facilities during normal 14-week season.
- .60 = Percent of weekly visitors on a normal summer Sunday.
- 1.5 = Rate of turnover

This formula, tried against experienced use at completed developments at New England Division Reservoirs, has proved to be fairly accurate. The initial design load for the project, based on an annual visitation of 110,000, is 2500. The initial development would have facilities adequate to accommodate the design load. The initial development would also include basic facilities which would be adequate for future as well as initial demand and which are more economically constructed in one stage rather than multi-stage. Such facilities include the administration and maintenance area, central roads, water supply, sewage disposal area, and beach development. The development would be expanded for future use over the life of the project based on design loads derived from the projected visitation shown in Figure 2, and/or as experienced use of the project may indicate.

b. Purchase Area. In order to realize utilization of the full potential of the resources of the Pontook Reservoir, it would be necessary to acquire additional land for recreational uses. The area to be acquired consists of 2,000 acres made up of (1) 400 acres at Holt Hill; (2) 1,100 acres on the easterly side of the reservoir in the town of Dummer from the dike northerly to the Cambridge line; and (3) 500 acres in a 200-foot strip contiguous to the 300-foot joint-use strip extending northerly from the Dummer-Cambridge line to Mollidgewock Brook, thus providing a 500-foot public access strip. These areas are shown on Plate G-1 and on Plate 2 of the Main Report. This land offers adequate area for land-based recreational development and insures against encroachment by private enterprise.

c. Development Features. Initial development to accommodate a design load of 2,500 users would have provisions for necessary access and a circulatory road network with adequate parking area for 500 cars. The picnic areas would have 75 picnic sites consisting of two picnic tables and one fireplace for each site and selective clearing as necessary. There would be 100 developed campsites with one picnic table and one fireplace each with an adequate cleared space for tent or trailer siting. Approximately 100,000 square yards of beach area would be developed to accommodate the initial anticipated use as well as the visitations for project year 100. It is considered desirable to develop the entire beach area initially as one stage construction in the interests of economy. Furthermore, future lowering of the pool for construction in multi-stage would most likely conflict with water needs for other purposes as well as hinder recreational use of the water surface.

The provision of the 7,500-acre water surface is expected to attract a large amount of boat use for pleasure boating and boat fishing. To accommodate these uses, a parking area for 120 cars with trailers and 40 cars without trailers would be provided. Mooring facilities would also be provided.

Central water supply and sewage disposal facilities would be developed for initial and projected use. Adequate toilet facilities would be provided in the initial development and supplemented as future use pressure requires.

Interpretive signs and tracts would be located where necessary.

6. ECONOMIC EVALUATION

a. Costs. Table G-3 itemizes the facilities and cost for initial development of the Pontook Reservoir. The initial cost of development is \$1,000,000 with a total accumulated cost of \$2,200,000 by project year 100. These costs include cost of basic facilities and do not include cost of land acquisition and project modifications. Figure 3 shows the accumulated project cost for incremental 5-year periods of the 100-year project life.

TABLE G-3

PONTOOK RESERVOIR COST ESTIMATE
INITIAL RECREATION DEVELOPMENT

<u>Item</u>	<u>Quantity</u>	<u>Unit Price</u>	<u>Estimated Cost</u>
<u>DAY USE - PARK AREA</u>			
1. Roads - Dbl. Bit. Treatment	4 mi.	\$25,000	\$ 100,000
2. Parking Areas	17,000 s. y.	2.00	34,000
3. Beach Development	100,000 s. y.	1.25	125,000
4. Picnic Tables	150 ea.	100.00	15,000
5. Fireplaces	75 ea.	90.00	6,750
6. Trash Barrels	150 ea.	10.00	1,500
7. Sanitary Facilities			
1 central change house toilet structure at beach area w/provisions for management and storage facilities. 16 change stalls, 12 water closets & 4 urinals. Flush- type toilets	1 job	L.S.	80,000
2 toilet structures w/1 urinal & 5 water closets each	2 ea.	20,000	40,000
		Sub Total	<u>402,250</u>
<u>CAMPING AREA</u>			
1. Roads - Dbl. Bit. Treatment	0.4 mi.	25,000	10,000
Gravel Surface	1.6 mi.	15,000	24,000
2. Campsites	100 ea.	200.00	20,000
3. Picnic Tables	100 ea.	100.00	10,000
4. Fireplaces	100 ea.	90.00	9,000
5. Trash Barrels	200 ea.	10.00	2,000

TABLE G-3 (cont'd.)

<u>Item</u>	<u>Quantity</u>	<u>Unit Price</u>	<u>Estimated Cost</u>
<u>CAMPING AREA (cont'd.)</u>			
6. Toilet structure w/urinal, 5 water closets, 2 shower stalls and 1 laundry tub	2 ea.	\$ 22,000	\$ <u>44,000</u>
		Sub Total	<u>119,000</u>
<u>BOAT LAUNCH & MARINA AREA</u>			
1. Parking Area	6,000 s.y.	2.00	12,000
2. Boat Launch Ramp	2 ea.	5,500	11,000
3. Building w/2 toilets and office space - 20' x 28'	1 ea.	10,000	10,000
4. Mooring Facilities	1 ea.	4,000	<u>4,000</u>
		Sub Total	<u>37,000</u>
<u>ADMINISTRATION & MAINTENANCE AREA</u>			
1. Entrance Station - 10' x 10'	1 ea.	4,000	4,000
2. One 4-stall garage w/office, toilet & workshop	1 ea.	25,000	25,000
3. One 5-room resident's quarters	1 ea.	24,000	<u>24,000</u>
		Sub Total	<u>53,000</u>
<u>CENTRAL WATER SUPPLY SYSTEM</u>			
1. Pipe lines @ 4.5' depth			
2" line	8,500 ft.	4.00	34,000
3/4" line	8,000 ft.	3.00	24,000
2. Well and Booster Pump Station	Job	L.S.	<u>10,000</u>
		Sub Total	<u>68,000</u>

TABLE G-3 (cont'd.)

<u>Item</u>	<u>Quantity</u>	<u>Unit Price</u>	<u>Estimated Cost</u>
<u>MISCELLANEOUS</u>			
Trails	4 mi.	\$2,500	\$10,000
Landscaping - Use \$1.50/D. L. visitor (N.P.S.)	Job	L. S.	3,750
Signs and Markers (Material only - work done in NED workshop)	Job	L. S.	1,000
		Sub Total	14,750
TOTAL CONSTRUCTION COST			694,000
Contingencies			136,000
TOTAL			830,000
Engineering & Design			90,000
Supervision & Administration			80,000
TOTAL COST INITIAL DEVELOPMENT -			\$ 1,000,000

AVERAGE ANNUAL COSTS

Operation & Maintenance	\$20,000(1)
Replacement	32,000(2)
Total	<u>\$52,000</u>

- (1) Annual Operation and Maintenance costs increase from \$11,000 in year one to \$41,000 in year 100. Increase = 41,000 - 11,000 = \$30,000

Average annual equivalent factor for 100 years at 3-1/8% = .28168

Average annual operation and maintenance = 11,000 + (30,000 x .28168) = \$20,000 (rounded)

- (2) Annual replacement costs for recreation facilities increase from \$23,000 in year one to \$55,000 in year 100. Increase = 55,000 - 23,000 = \$32,000

Average annual equivalent factor for 100 years at 3-1/8% = .28168

Average annual replacement = 23,000 + (32,000 x .28168) = \$32,000

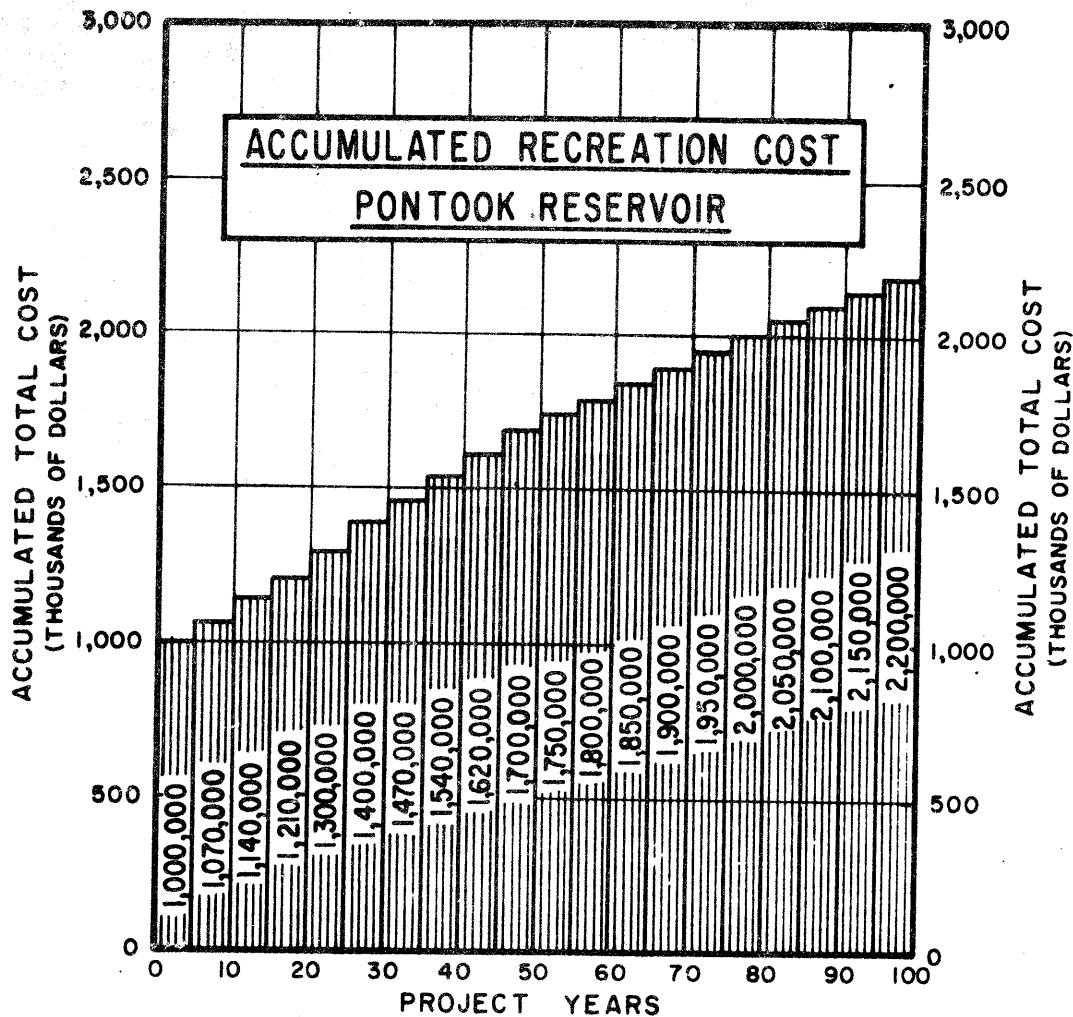
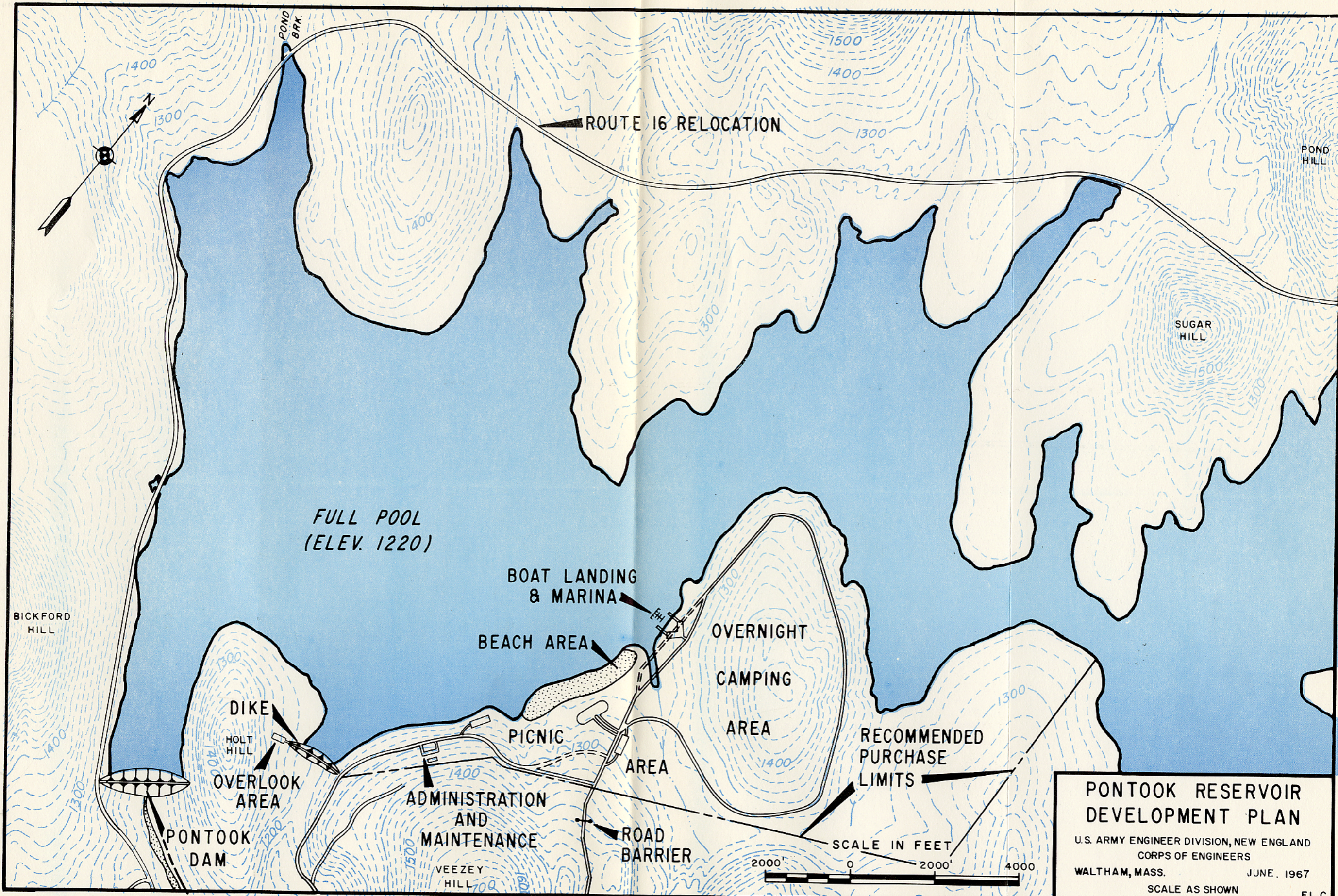


FIGURE 3

b. Benefits. Recreation benefits included in this evaluation are for uses of the developed recreational area and do not include visits to the project by sightseers, fishermen or hunters enjoying the natural resources of the project. A value of \$1.50 per visitor-day has been chosen since the Pontook Reservoir with a properly planned development is expected to offer a highly diversified water-based outdoor recreation resource unsurpassed in northern New England. With this unit value, annual benefits should reach \$165,000 upon completion of the project and reach \$606,000 annually by project year 100. Average annual equivalent benefits are \$289,000 over the project life.



PONTOOK RESERVOIR DEVELOPMENT PLAN

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS

WALTHAM, MASS.

JUNE, 1967

SCALE AS SHOWN

F.L.C.

PLATE NO. G-1

APPENDIX H
FISH AND WILDLIFE RESOURCES

APPENDIX H
FISH AND WILDLIFE RESOURCES

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ATTACHMENT

Report by U. S. Department of the Interior,
Fish and Wildlife Service

APPENDIX H

FISH AND WILDLIFE RESOURCES

1. GENERAL

The Bureau of Sport Fisheries and Wildlife, Fish and Wildlife Service, Department of the Interior, (hereinafter referred to as the "Bureau"), has made several studies of the impact of the Pontook project on the fish and wildlife resources in the area. A copy of the Bureau's latest report dated 4 April 1967 is included in this appendix.

2. SUMMARY OF BUREAU REPORT

The Bureau finds that the project will destroy 37 miles of excellent cold-water stream fishery, 7,500 acres of terrestrial wildlife habitat, including 4,600 acres of deer-wintering habitat, a small acreage of fur-animal habitat, and over 115 acres of waterfowl marsh. It notes that the project will provide a much larger, warm-water lake-type fishery which will not, however, in its opinion, replace the valuable cold-water stream fishery lost.

The report recommends that the Pontook Dam and Reservoir project not be constructed.

3. EVALUATION OF REPORT

The Bureau states in its report that there is no way to replace the cold-water stream fishery if once lost. Furthermore, it has explored methods of mitigating project-occasioned losses to the deer resource. At best, it appears possible to regain, through habitat development, only a portion of the deer population which would initially be lost through project construction.

An evaluation has been made of the reported losses and gains to the fish and wildlife resources which would result from construction of the Pontook project. Table H-1 summarizes the losses and gains and assigns, to each class, a unit value in consonance with Supplement No. 1 of Senate document 97, 87th Congress and in recognition of the excellent quality of some of the resources to be lost. The table indicates that there would be a net loss of approximately \$662,000, which is included as a project economic cost.

4. DISCUSSION AND CONCLUSION

It is considered that the report and findings of the Bureau are responsible. The recommendations appear to be consistent with present laws, policies, and inter-agency agreements.

It is concluded that the report and recommendations of the Bureau be accepted and included as part of the Federal cost of the Pontook project.

TABLE H-1

PONTOOK PROJECT
EFFECT ON FISH AND WILDLIFE RESOURCES

	Unit Value per Man-Day	<u>Without the Project</u>		<u>With the Project</u>		<u>Overall gain(+) or Loss(-)</u>	
		Man-Days	Amount	Man-Days	Amount	Man-Days	Amount
Warm-Water Lake Fishery Without the Project	\$1.00	3,000	\$ 3,000	--	--	- 3,000	-\$ 3,000
Warm-Water Lake Fishery With the Project	2.00	--	--	12,000	\$24,000	+12,000	+ 24,000
Cold-Water Stream Fishery	4.00	115,000	460,000	0	0	-115,000	- 460,000
Big Game Hunting	6.00	36,000	216,000	0	0	-36,000	- 216,000
Small Game Hunting	2.00	1,800	3,600	300	600	- 1,500	- 3,000
Waterfowl Hunting	5.00	450	2,250	150	750	- 300	- 1,500
Trapping	--	--	<u>3,150</u>	--	<u>650</u>	---	<u>- 2,500</u>
TOTALS			\$688,000		\$26,000		-\$ 662,000

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

Clarence F. Pautzke, *Commissioner*

PONTOOK RESERVOIR

ANDROSCOGGIN RIVER

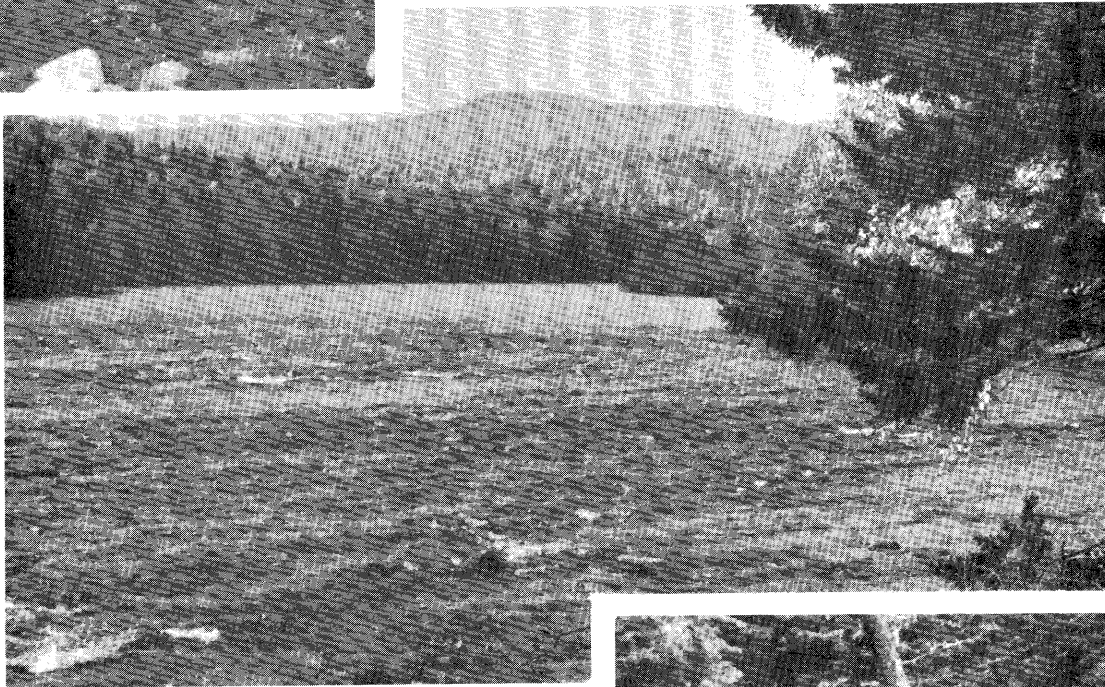
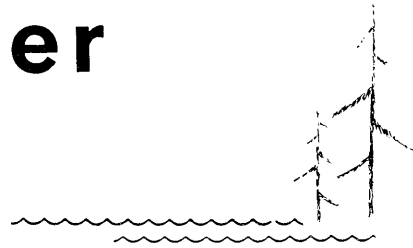
MAINE AND NEW HAMPSHIRE

A Conservation and Development Report on Fish and Wildlife Resources

for wading



Cool Clear Water

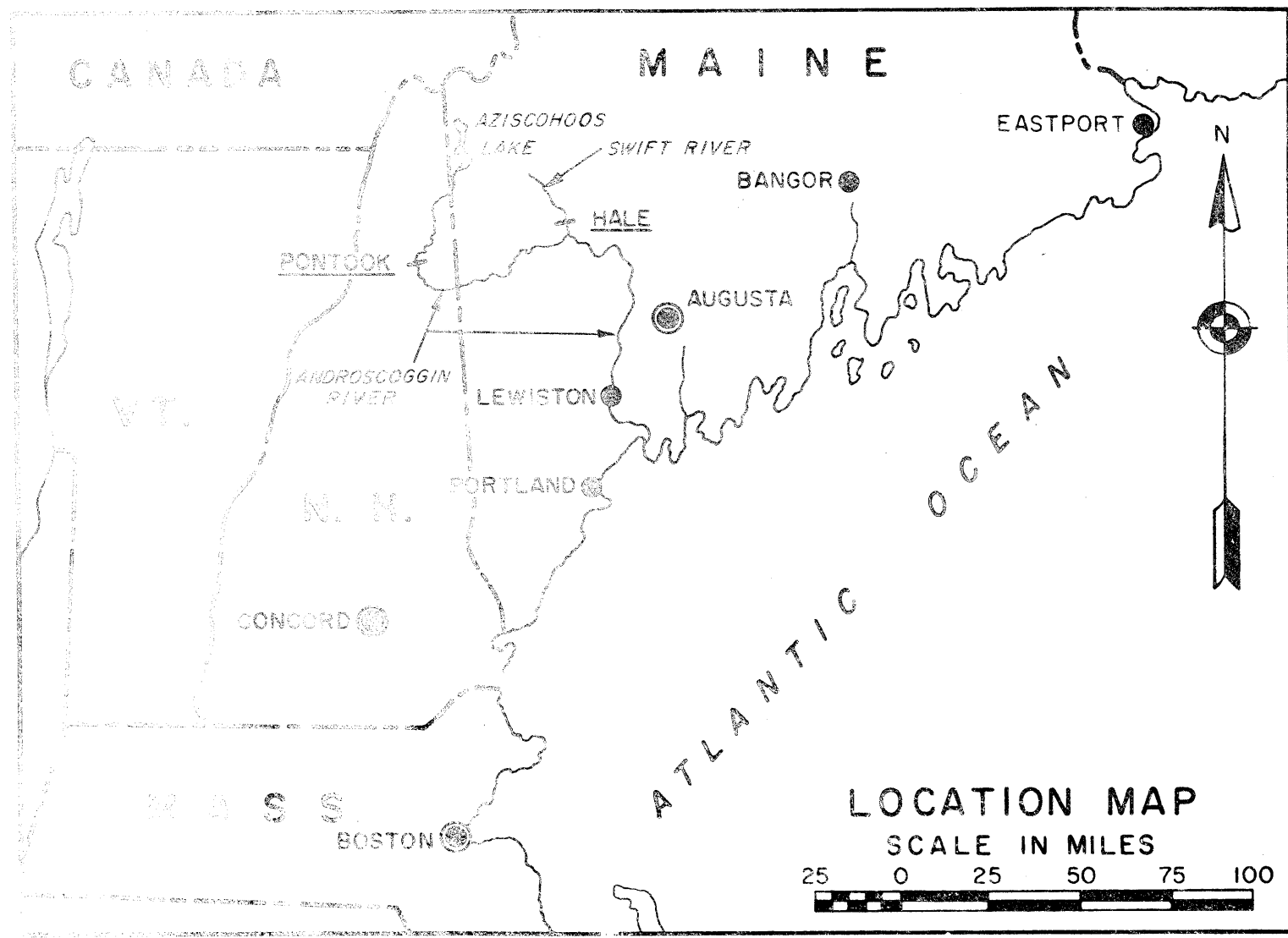


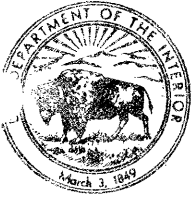
the river flowing

Androscoggin River



for floating





UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
U. S. POST OFFICE AND COURTHOUSE
BOSTON, MASSACHUSETTS 02109

April 4, 1967

Division Engineer
U. S. Army Engineer Division, New England
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Sir:

This letter constitutes our conservation and development report on the fish and wildlife resources associated with the Pontook Dam and Reservoir project on the Androscoggin River, Coos County, New Hampshire. Authorization for your study was contained in the Resolution of the Senate Public Works Committee adopted November 21, 1955. This report has been prepared under authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661-666 inc.), in cooperation with the New Hampshire Fish and Game Department, and has its concurrence as indicated by letter dated March 27, 1967.

We understand that project plans provide for a multiple purpose dam and reservoir designed for flood control, hydroelectric power, and recreation, and a reregulating dam and reservoir downstream from the main dam.

According to data received from your staff the damsite for Pontook Reservoir is located on the Androscoggin River about 12 miles upstream from Berlin, New Hampshire, and about one mile downstream from the existing Pontook Dam. An area of 7,470 acres will be inundated when reservoir storage is at full pool, elevation 1220.^{1/} This is 96 feet above the streambed at the dam. The site for the reregulating dam is six and one-half miles downstream from the site of the new Pontook Dam. It is situated in Milan at the head of the Brown Company's "Sawmill Pond."

The power house will be incorporated in the main dam.

For the Pontook Reservoir about 9,300 acres of land will be acquired in fee title to elevation 1220 plus a horizontal strip 300 feet wide, from the dam upstream to Mollidgewock Brook on the east shore of the pool and to Pond Brook

^{1/} All elevations are in feet above mean sea level.

on the west shore. In addition, about 2,000 acres of land will be acquired for recreation purposes with the major portion located on the east shore of the reservoir between the dam and Bog Brook. This includes a 200-foot strip of land adjacent to the horizontal strip 300 feet wide, from the dam upstream to Pond Brook on the west shore. A 300-foot strip of land will be acquired around the remaining portions of the main reservoir and around the reregulating reservoir. About 1,900 acres of land will be acquired for the reregulating reservoir.

The Androscoggin River is one of the larger New England rivers, carrying waters from Canada, New Hampshire, and Maine. From its head at Umbagog Lake to tide-water at Brunswick, Maine the river has a length of 161 miles and an average gradient of 7.7 feet per mile. In the eighteen miles between the Errol Dam (near the upper reach of the new reservoir) and Pontook damsite the stream drops 100 feet in elevation.

As measured at the Errol, New Hampshire gauging station, average annual streamflow is 1,890 c.f.s. (adjusted 53-year period). The maximum daily flow recorded since December 9, 1943 (when this flow record began) is 15,700 c.f.s. Because leakage occurs when gates in the Errol Dam are closed, no data are available on the minimum daily streamflow. An agreement between the Union Water Power Company (who operate the Errol Reservoir) and several downstream users provides, insofar as possible, for a minimum flow of 1,550 c.f.s. at Gorham, New Hampshire. Since 1929, flows below the desired minimum have occurred occasionally.

The general topography of the upper Androscoggin watershed consists of a complex of mountains and hilly uplands dissected by many narrow valleys. Flats of various widths border the river and larger tributaries. Most of the project area is forested. Relatively pure stands of conifers account for about half of the total woodland; mixed hardwoods and conifers, hardwoods, and alder swamp comprise the remainder. All stages of forest succession are represented as a result of lumbering and pulpwood operations. Hayfields and farmlands (often abandoned or fallow), open swamps, and water account for the bulk of the unforested acreage.

The Berlin National Fish Hatchery, Milan Hill State Park, and sections of the White Mountain National Forest are located in the vicinity of the project.

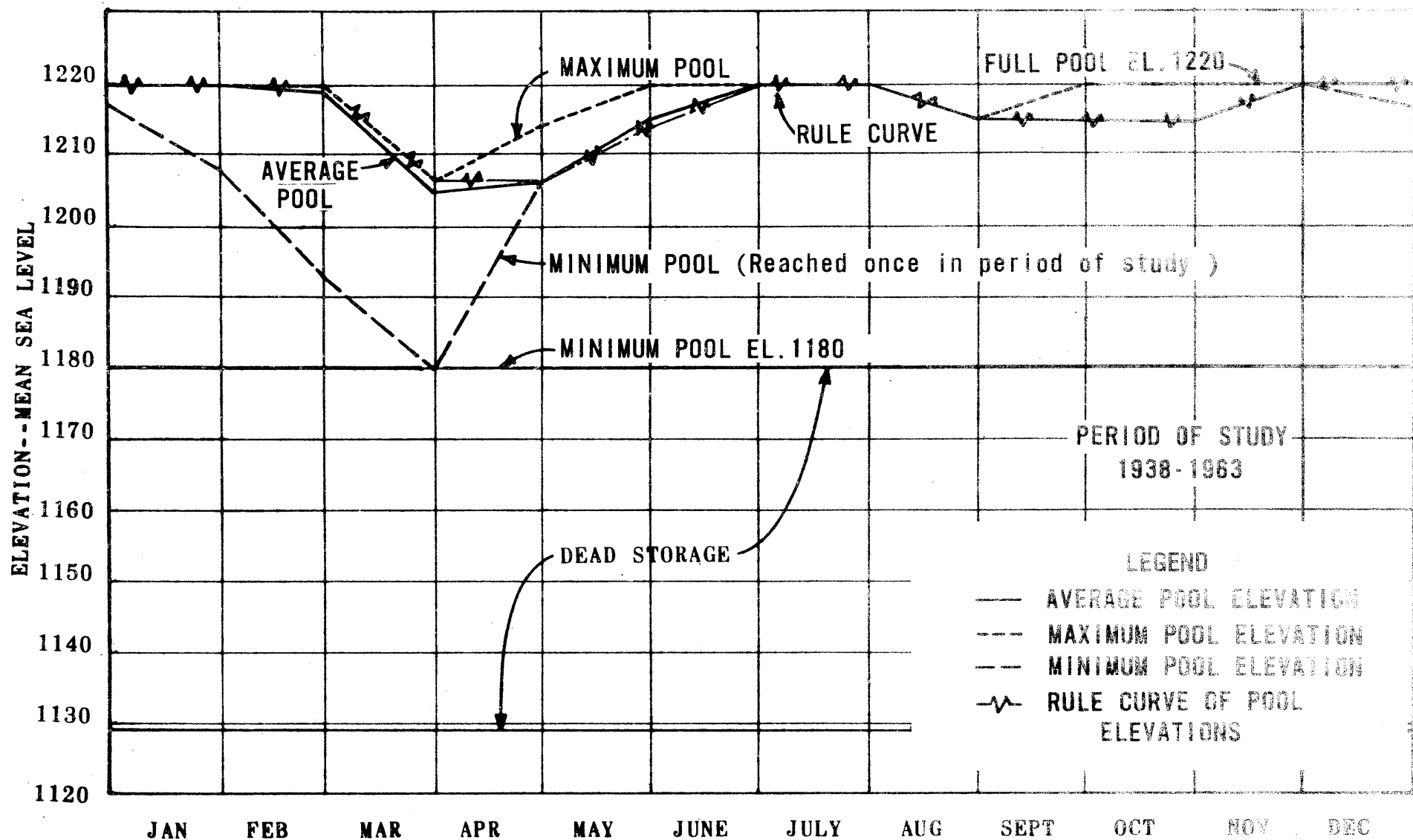
We understand that project operation will be generally as follows. Power normally will be generated about one and one-half hours per day, five days per week, during late afternoon and morning periods to meet peak power demands.

Discharges from Pontook Dam will be a maximum 42,000 c.f.s. when power is generated. The remainder of the time the turbine gates will be closed, and the discharge due to leakage and seepage may be as high as 211 c.f.s.

The reservoir pool will be held as close as possible to the full pool, elevation 1220, during January and February to produce maximum power. A drawdown will commence about March 1 and continue to April 1 or until the pool reaches elevation 1206. The pool will then be refilled gradually with snow-melt runoff starting on May 1 until it reaches elevation 1220 about the first of July. It will be held as near as possible to this elevation through July. During this period the daily fluctuation will be less than one foot. The full pool will be drawn down during the fall to provide for flood storage. By early September the pool will be at elevation 1215 where it will be held until the first of November; thereafter it will be refilled until it reaches elevation 1220 by December 1. Water releases from Errol Dam and upstream storage will be used to stabilize the Pontook pool. Figure 1 shows the average, maximum, and minimum pool elevations for the period of study.

The reregulating reservoir will have a maximum weekly fluctuation of 20 feet. It will provide a continuous downstream flow of 1724 to 2500 c.f.s. The depth of the reregulating reservoir insures a continuous pool extending to the foot of the Pontook Dam. The peak-period operation of the Pontook Dam will result in violent water surges in the reregulating reservoir making this reservoir unsafe for fishing. When the penstocks are opened, there will be an extremely rapid rise in water levels in the reregulating reservoir waters immediately downstream from the powerhouse. Although this wave will have almost subsided by the time it reaches the reregulating dam a mild upstream resurge is anticipated.

That segment of Androscoggin River affected by the project from Errol to the reregulating damsite in Milan supports both a warm and a cold-water fishery. The existing Pontook Reservoir, a shallow impoundment having a maximum depth of about 15 feet, extends upstream to the mouth of Big Brook and covers some 543 acres. It supports a warm-water fishery consisting of excellent populations of chain pickerel and brown bullhead. Several species of lesser importance also occur here. Because warm-water species at present attract a few fishermen in New Hampshire, the fishing pressure is light. Projected over the period of analysis, the existing reservoir fishery use is expected to average about 3,000 fisherman-days annually.



Source of data:
Corps of Engineers

ANDROSCOGGIN RIVER BASIN , N.H. & MAINE
POOL ELEVATIONS-PONTOOK PROJECT

Figure 1

The finest cold-water stream fishery remaining in the State lies within the area of project influence. This fishery consists of approximately 19 miles of the Androscoggin River and 18 miles of tributary streams. The wide, fast-running reaches of the main stem within the project area represent about 98 percent of the remaining superlative cold-water stream fisheries in New Hampshire. In fact, dams and pollution have already destroyed most of the once abundant large-stream trout and salmon fisheries in all New England. The clear, clean riffles and pools in this segment of the Androscoggin River are bordered by miles of unspoiled forest.

The upper Androscoggin has spawning areas for resident fishes, and natural reproduction provides an important segment of the angler catch. These same spawning areas are suitable for Atlantic salmon, an anadromous species long barred from the Androscoggin by dams and gross pollution beginning at Berlin and extending to the ocean. The State supplements the natural reproduction with regular releases of hatchery-reared brook, rainbow, and brown trout and occasional releases of landlocked salmon.

Stream-fishing pressure is increasing annually, a reflection of the increasing interest in this area remote from population centers. An appreciable number of the anglers are either from distant points in the State or from other States. The cold-water stream fisheries within the area influenced by the project support a present fishing pressure of about 52,000 fisherman-days annually. Creel censuses on the Androscoggin upstream from Berlin disclose that trout constitutes about 94 percent of the catch. The fishing success is considerably better today than it was only 10 years ago due to an improved stocking program and the fact that the river is no longer used for floating logs to the mills.

Based on recent fisherman surveys made by the New Hampshire Fish and Game Department and on projections of fishing demands reported by the Outdoor Recreation Resources Review Commission, it is conservatively estimated that this excellent stream fishery will provide an average of 115,000¹/fisherman-days annually.

The new Pontook Reservoir will inundate the existing Pontook Reservoir and 27.5 miles of the cold-water stream fishery. The reregulating reservoir will

¹/ The estimate of the New Hampshire Fish and Game Department is 134,200 fisherman-days.

inundate 9.5 miles of stream fishery. The inundation will result in the total loss of the 37 miles of stream fishery, virtually all of the remaining high quality stream fishery in the State. In its place will be a low quality warm-water reservoir fishery which is expected to have an average annual utilization of not more than 12,000 fisherman-days annually. The reregulating reservoir is not expected to provide any fishing opportunities due to the violent daily or twice daily surges which will make it unsafe for fishing. Neither will there be an increase in downstream fishing opportunities since this reservoir will discharge directly into Sawmill Pond which has a limited cold-water fishery.

Virtually all of the wildlife species indigenous to central and northern New Hampshire occur in the area affected by the two reservoirs. Big game is the most important. The whitetail deer is the principal species, but there are some black bears and a few moose. Bears are usually taken during the deer season. The moose is a protected species, but its presence adds considerably to the aesthetic quality of the area. This is exceptionally good deer range, containing wintering yards essential for deer survival in these latitudes. Within the full-pool contour, elevation 1220, are approximately 4,600 acres of deer yards consisting of mature coniferous stands, interspersed with essential deciduous browse species.

Recent investigations indicate that deer yards within the project area winter a population capable of producing an average annual increment of about 700 animals that could be harvested by hunters. Today the harvest is somewhat less than this figure, but with increasing hunting pressure, together with good deer habitat management and hunting regulations, it is estimated that the average annual harvest over the period of analysis will be 600 animals. Based on a statewide deer-hunter survey by the New Hampshire Fish and Game Department, the deer harvest will provide for 36,000 hunter-days annually. About half of the deer hunters are local sportsmen; a portion of the remainder come from other States.

Small-game hunting on the project area attracts relatively few hunters; these are mainly local sportsmen. Snowshoe hare, woodcock, and ruffed grouse are the principal species sought. The average annual utilization of this resource under without-the-project conditions is estimated at 1,800 hunter-days.

The project area contains one of the more important and extensive waterfowl areas in northern New Hampshire, a region with a paucity of good waterfowl habitat and huntable duck populations. Included in the habitat are 115 acres

classed as excellent, plus a larger acreage of lower value habitat. Virtually all Atlantic Flyway species of ducks utilize the area; black ducks and wood ducks, however, are most common and both species nest here. The habitat will provide for an average of 450 waterfowl-hunter days annually over the life of the project.

Fur animals on the project area include muskrat, mink, otter, bobcat, beaver, fisher, raccoon, red fox, weasel, marten, and skunk. The beaver resource has an excellent but largely unrealized potential. The present fur harvest yields about 400 muskrat pelts, 25 beaver, 10 mink, five otter, and a scattering of other species. Over the project life the average annual fur harvest is expected to double that of today.

Approximately 7,500 acres of terrestrial wildlife habitat (including marsh) will be totally lost in the two reservoirs due to inundation. Virtually all land use and cover types except upland forest are represented in the acreage to be inundated.

The most serious loss will accrue to the deer resource through the elimination of 4,600 acres of deer-wintering habitat. Since the deer yards that will not be inundated are already fully utilized, displaced deer cannot survive. Project construction therefore will result in a loss of the population of deer that would have been maintained by the 4,600 acres of wintering habitat. This represents a loss in deer-hunting opportunity amounting to 36,000 hunter-days annually, at present levels of hunter success.

Project construction will inundate an important segment of the small-game habitat, notably alder thickets, open fields, and field borders. This will result in an annual small-game loss representing a related loss in hunter-days amounting to 1500.

The Pontook Reservoir will inundate the 215 acres of excellent waterfowl marsh having relatively stable water levels. A larger acreage of poorer habitat will be inundated. All this will be replaced by a more extensive but even poorer aquatic habitat. The new reservoir will be subject to both daily and seasonal fluctuations, a situation not conducive to duck nesting or to any significant production of aquatic waterfowl foods. With the project the man-days of waterfowl hunting will be reduced to 150, with a related loss of 300 hunter-days annually.

Under with-the-project conditions, comparatively small existing acreage of good to excellent fur-animal habitat will be inundated. In its place a much

greater acreage of poor habitat will be substituted. The latter will be characterized by daily water level fluctuations of about one foot. The net result will be a loss of the fur-animal resource.

As indicated above, construction of this project will have a devastating effect on the finest remaining stream fishery and the most important deer-wintering area in New Hampshire. In addition to these great losses, there will be an immeasurable loss in the overall aesthetic quality of the area, from the viewpoint of the hunter and fisherman. Because of the ever-decreasing number of truly wild areas such as the upper Androscoggin River, those remaining are of increasing importance not only to the hunter and fisherman but to the expanding numbers of people who have other wildlife-oriented interests such as nature study and wildlife photography.

There is no way to replace this valuable cold-water stream fishery if once lost. The fact that this fishery represents the last of its quality in the State and attracts increasing numbers of fishermen each year makes its preservation highly desirable. New Hampshire, furthermore, has about 1,200 lakes already that provide warm-water fisheries, all of which receive light fishermen use in contrast to the great demand for cold-water stream fisheries; another warm-water fisheries impoundment, therefore, is not required to meet present or foreseeable future needs for that type of fishing opportunity.

We have explored methods of mitigating project-occasioned losses to the deer resource. At best, it appears possible to regain through habitat development only a portion, probably not over half of the deer population which would initially be lost through project construction.

In view of the facts that project construction will destroy 37 miles of an irreplaceable cold-water stream fishery of unsurpassed quality and 4,600 acres of the finest deer-wintering yards in New Hampshire and that these resources are of critical importance to meeting present and future needs for related recreational opportunities in New Hampshire and, to a lesser degree, the entire northeastern United States, the Bureau of Sport Fisheries and Wildlife recommends:

1. That the Pontook Dam and Reservoir project not be constructed.
2. That, if construction of the project is authorized,

additional detailed studies of fish and wildlife resources be conducted as necessary in accordance with Section 2 of the Fish and Wildlife Coordination Act; and that such reasonable modifications be made in the authorized project facilities as may be agreed upon by the Secretary of the Interior and the Secretary of the Army, for the conservation, improvement, and development of these resources.

Sincerely yours,


Acting Regional Director

APPENDIX I
OTHER PROJECTS STUDIED

APPENDIX I
OTHER PROJECTS STUDIED

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APPENDIX I

PART I - DAMS AND RESERVOIRS

1. INTRODUCTION

Over 50 sites were considered for possible flood control and multiple-purpose dams and reservoirs. Of these, over 20 were eliminated early in the preliminary investigation because the benefits creditable were obviously insufficient to warrant additional studies. About half of the remaining 30 sites were considered in a prior survey report of 1938 and in the New England-New York Inter-Agency Committee report of 1955. By updating and using the maximum value assigned to flood control storage per acre-foot from the latter report, it was possible to determine which reservoir sites had sufficient economic justification to warrant a more detailed study. The storage value for any site was based on a hydrologic analysis of the flood potential of the basin; the existing reservoir storage in the basin; newly acquired flood damage data; and an assumed flood control storage of at least 6 inches of runoff from the intercepted drainage area. Based on preliminary estimated costs and economic data compiled for the 30 remaining reservoir sites selected for investigation, it was found that 11 sites were worthy of detailed study. Of these, the Pontook project was found economically justified and is further described elsewhere in this report. In evaluating the various projects, consideration was given to including facilities for hydroelectric power generation, water supply, recreation, and fish and wildlife enhancement. The following paragraphs describe the reservoir projects studied in some detail but not recommended. These studies were made at the 1964 price level. It is considered that updating to 1966 price level would not change the conclusions. In addition, the power benefits in these studies are based on the cost of a steam-electric plant determined by the Federal Power Commission to be the least costly alternative whereas the latest letter from the Federal Power Commission dated 23 March 1967 (Attachment I, Exhibit 1) states that the least costly alternative is now considered to be pumped storage. The estimates were not changed because the conclusions would not be affected. The Hale and Ellis Dams and Reservoirs were studied in more detail since these projects showed the most promise of being economically justified. A summary of pertinent dam and reservoir data is given in Table I-1 at the end of this appendix.

2. HALE PROJECT

a. General. Two plans were considered -- one for flood control only, the second for multiple-purpose flood control, power, and recreation. The latter provided the higher benefit-cost ratio and is described in the following paragraphs. Pertinent data for both plans are shown in Table I-1.

b. Main Dam and Reservoir.

(1) Description.

(a) Dam. The Hale damsite is located on the Swift River, approximately 2 miles above its mouth, in the town of Mexico, Maine. The dam, for multiple-purpose use, would be of rolled earth-fill, approximately 2,800 feet long, with a maximum height of 255 feet above the river bottom, and a top elevation of 784 feet above mean sea level. A chute spillway with a concrete ogee weir, 220 feet long and crest at elevation 763, would be located in the west abutment. A powerhouse would be located at the downstream toe of the dam, with a penstock intake works, containing an 18-foot by 16-foot bulkhead gate, at the upstream toe. A 13.5-foot diameter steel-lined concrete conduit would lead from the intake works to immediately above the powerhouse where it would split into two $8\frac{1}{2}$ -foot penstocks and one 10-foot diameter conduit to the power plant. The $8\frac{1}{2}$ -foot penstocks would be connected to two 21,000 horsepower Francis turbines. The 10-foot conduit would be used to discharge flood control storage at a rate equal to bankfull capacity of the river.

(b) Reservoir. The reservoir at spillway crest elevation 763 would be approximately $8\frac{1}{2}$ miles long, have a surface area of 3,800 acres, and a gross capacity of 332,000 acre-feet. The reservoir would provide storage of 47,400 acre-feet for flood control purposes between elevation 763 and 750, and 96,600 acre-feet for power purposes between elevation 750 and 714. A total gross head of 250 feet would be developed between a power pool elevation of 750 and a tailwater elevation of 500 at the powerhouse. Generating facilities for 33,750 kilowatts, in two units, would be installed in the powerhouse. The plant would produce about 31.0 million kilowatt-hours annually at a capacity factor of about 9 percent. Sufficient flood control storage would be provided in the reservoir to store 8 inches of runoff from the tributary drainage area of 111 square miles.

(2) Recreation. Land and water areas in and adjacent to the reservoir would be developed for recreational activities and wildlife conservation. Initial facilities would provide for swimming, picnicking, camping, boating, hunting, fishing, and other water related uses.

c. Reregulating Dam and Pool.

(1) Description.

(a) Dam. Since there would be a need for control of the high releases from the power house, a reregulating dam would be provided about one mile downstream of the main dam. The structure would have an overall length of approximately 1,580 feet of which 190 feet is a fixed-crest concrete spillway, and the remainder rolled earth fill. The top of the dam would be at elevation 500 and have a maximum height of 52 feet. The crest of the spillway would be at elevation 486. A 24-foot wide public roadway would be provided on top of the dam with a steel girder bridge spanning the spillway.

(b) Pool. The pool at spillway crest elevation 486 would have a surface area of 40 acres, and a gross capacity of 610 acre-feet. A low flow discharge of not less than the present minimum flow on the river would be provided through an ungated 42-inch diameter opening in the spillway in conjunction with a 12-inch diameter conduit through the embankment in the river bed.

No improvements for the development of recreational facilities would be provided for the pool area.

d. Project Cost. The total cost of the multiple-purpose project is estimated to be \$31.1 million with annual charges of \$1,193,000. Benefits would total \$912,000, consisting of \$183,000 for flood control, \$704,000 for power, and \$25,000 for recreation, giving a benefit-cost ratio of 0.8 to 1.

3. MOOSE RIVER DAM AND RESERVOIR

The dam site is located on the Moose River about 3-3/4 miles above its confluence with the Androscoggin in the town of Gorham, New Hampshire. The project, for flood control only, would require a rolled earth dam approximately 720 feet long, a maximum height of 120 feet, and top at elevation 1,250 feet above mean sea level. The dam would impound 8,500 acre-feet of flood control storage to control 8 inches of runoff from the tributary drainage area of 20 square miles. The spillway crest would be at elevation 1,231. The dam site is located within a narrow rock gorge. A railroad which follows the river through the reservoir area would require relocation. Modifications required in the project to include hydroelectric power would include an increase in the height of the dam to elevation 1,260 and crest of spillway to elevation 1,240. The reservoir would provide a storage of 8,500 acre-feet for flood control and 2,900 acre-feet for power purposes. A gross head of 72 feet could

be developed between a pool elevation of 1,202 and a tailwater elevation of 1,130. Generating facilities for 1,500 kilowatts would be installed in the powerhouse located at the downstream toe of the dam. The plant would produce about 1.3 million kilowatt-hours annually at a capacity factor of about 10 percent. The total cost of the multiple-purpose project is estimated to be \$3.6 million with a benefit-cost ratio of 0.7 to 1. The total cost of the project for flood control alone is estimated to be \$1.8 million with a benefit-cost ratio of 0.6 to 1. There is no expressed need at this time for water supply or water quality storage features.

4. PEABODY RIVER DAM AND RESERVOIR

The dam site is on the Peabody River, approximately 2 miles above its mouth in the town of Gorham, New Hampshire. The project constructed for flood control alone would consist of a rolled earth dam approximately 2,360 feet long and 160 feet high with top at elevation 1,081, above mean sea level; a concrete spillway 229 feet long with crest at elevation 1,062; and gated outlet works. The reservoir at spillway crest would be $1\frac{1}{2}$ miles long, have a surface area of about 370 acres, and a flood control storage capacity of 18,500 acre-feet, equivalent to about 8 inches of runoff from the tributary drainage area of 43 square miles. About $2\frac{1}{2}$ miles of Route 16 would require relocation to higher ground along the perimeter of the reservoir. The generation of hydroelectric power was also considered for the project. Such a development would require a dam with top at elevation 1,119, a spillway with crest at 1,100, and reservoir storage of 18,500 acre-feet for flood control purposes, and 16,500 acre-feet for power purposes. A total gross head of 138 feet could be developed between a maximum pool elevation of 1,058 and a tailwater elevation of 920 at the power house located at the downstream toe of the dam. Generating facilities for 6,000 kilowatts would be provided in the power house. The plant would produce about 5.4 million kilowatt-hours annually at a capacity factor of about 10 percent. The project including flood control and hydroelectric power is estimated to cost \$12.2 million and have a benefit-cost ratio of 0.6 to 1. A project considering flood control alone would cost about \$4.7 million and have a benefit-cost ratio of 0.5 to 1.

5. WILD RIVER DAM AND RESERVOIR

The dam site is located in the White Mountain National Forest, on the Wild River about 4 miles above its confluence with the Androscoggin River in the township of Batchelders Grant, Maine. The project

constructed for flood control alone would require a rolled earth dam about 1,300 feet long and 125 feet high. The dam would provide 15,700 acre-feet of flood control storage to control 6 inches of runoff from the tributary drainage area of 49 square miles. Spillway crest would be at elevation 960 and the top of the dam at elevation 975 feet, above mean sea level. A secondary road within the reservoir area would be relocated outside the limit of the full flood pool. To include hydroelectric power in the project, the top of the dam would be at elevation 1,015 and the crest of the spillway at elevation 1,000. The reservoir would provide flood control storage of 15,700 acre-feet, and 13,400 acre-feet of storage for power purposes. A gross head of 113 feet could be developed between a headwater elevation of 953 and a tailwater elevation of 840 at the power plant located at the downstream toe of the dam. Generating facilities for 6,000 kilowatts would be installed in the powerhouse and would produce about 5.0 million kilowatt-hours annually at a capacity factor of about 10 percent. The multiple-purpose project is estimated to cost \$8.2 million and have a benefit-cost ratio of 0.9 to 1.0. A project constructed for flood control alone would cost approximately \$3.2 million and have a benefit-cost ratio of 0.6 to 1.0.

6. ELLIS RIVER DAM AND RESERVOIR

The Ellis River dam site is located on the Ellis River approximately one mile above its confluence with the Androscoggin River in the town of Rumford, Maine. The project was studied for flood control alone and for flood control in combination with recreation and hydroelectric power. None of the studied plans is economically justified at this time. An elevation of 660 was determined as being the maximum permissible pool surface to prevent flooding in the communities of Andover and East Andover, Maine. The following subparagraphs briefly describe the projects studied.

a. Flood Control Only. The project would consist of a rolled earth dam approximately 800 feet long, a maximum height of 56 feet, and a top elevation of 671. A rolled earth dike about 2,500 feet long and 36 feet high would be required to close a saddle in the perimeter of the reservoir. A chute type spillway 450 feet long with crest at elevation 651 and gated outlet works would also be provided. The reservoir impounded by the dam would have a flood control storage of 70,000 acre-feet equivalent to 8 inches of runoff from the tributary drainage area of 164 square miles. The total cost of the project is estimated to be \$6.3 million, with a benefit-cost ratio of 0.8 to 1.

b. Flood Control and Recreation. This project is similar to the project described above except that the elevation of the top of the dam, dike, and crest of spillway are each increased by 8 feet, and the length of the dam and dike are increased by 50 and 380 feet, respectively. A weir with crest at elevation 642 would also be required for the regulation of the recreation pool. The reservoir would provide a storage of 70,000 acre-feet for flood control and 40,000 acre-feet for recreation. The total cost of the project is estimated to be \$7.3 million, with a benefit-cost ratio of 0.8 to 1.

c. Flood Control, Recreation and Hydroelectric Power. The project would require a rolled earth dam approximately 860 feet long, at a maximum height of 65 feet, and a top elevation of 680. The dike would be about 2,900 feet long and 45 feet high. A chute type spillway would be 450 feet long and have a crest elevation of 660. A reservoir regulating structure would be provided at the upstream toe of the dam. The reservoir would provide a flood control storage of 70,000 acre-feet, and 43,000 acre-feet for power purposes. A gross head of 28 feet would be developed between a pool elevation of 643 and a tailwater elevation of 615 at the power plant located at the downstream toe of the dam. Generating facilities for 5,000 kilowatts would be installed in the power house that would produce about 4.0 million kilowatt-hours of energy annually at a capacity factor of about 10 percent. The total cost of the project is estimated to be \$10.3 million, with a benefit-cost ratio of 0.8 to 1.

d. Change in Hydraulic Analyses. There are no official records of flow on the Ellis River. Therefore, the discharge data available for the Swift River - a tributary of the Androscoggin River approximately 7 miles to the east of and paralleling the Ellis River - was assumed applicable for the study of this project. Upon completion of preliminary investigations, it appeared that the project should be studied further because of the relatively high degree of economic feasibility. During a field survey of the project area, local residents questioned the value of a flood control reservoir on the Ellis River. It was their opinion, based on observation, that the rapid rise of flood waters on the Androscoggin River produced reverse flow in the lower Ellis River, thereby reducing the Ellis River contribution to the main river flood. Since the discharge reductions assigned to a reservoir determines its economic feasibility, further study on the project was deferred until more field data could be obtained to determine the flood hydraulics of the lower Ellis River. This phenomenon is further described in paragraph 11a of Appendix B.

7. RUMFORD DAM AND RESERVOIR

The Rumford project was investigated for flood control alone and for multiple-purpose use including power and recreation. The dam site is located on the Androscoggin River 93 miles above its mouth in the town of Rumford, Maine. The project constructed for flood control alone would require a structure consisting of a concrete spillway 1,400 feet long and rolled earth abutments. The overall length of the structure would be approximately 1,620 feet. The crest of the spillway would be at elevation 652, and the top of the dam would be at elevation 670 with a maximum height of 62 feet. The reservoir created by the structure would be approximately 20 miles long and would impound 237,000 acre-feet of flood control storage to control 4.5 inches of runoff from the net tributary drainage area of 988 square miles below Errol Dam. A dike, having an overall length of 3,000 feet and a maximum height of 35 feet, would be required to close a saddle in the perimeter of the reservoir. Bedrock is not available at the dam site. The reservoir area consists of farmland and woodland. Approximately 22 miles of highways and 7 miles of secondary roads would require relocation and/or raising. About 2 miles of railroad track would also require raising. There are approximately 270 buildings within the full flood pool area including 3 churches and 5 schools. Two cemeteries containing approximately 2,000 graves require relocation. The modifications required in the project to provide hydroelectric power and recreation would include increasing the height of dam to elevation 693 and crest of spillway to elevation 675. A storage of 316,000 acre-feet, equivalent to 6 inches of runoff from the tributary drainage area, would be provided for flood control and 344,000 acre-feet for power purposes. A gross head of 49 feet would be developed at the power plant located at the toe of the dam. Generating facilities of 56,250 kilowatts in the power house would produce about 74 million kilowatt-hours annually at a capacity factor of about 10 percent. The multiple-purpose project is estimated to cost \$57.5 million and have a benefit-cost ratio of 0.8 to 1.0. The project for flood control alone would cost \$20.7 million and have a benefit-cost ratio of 0.7 to 1.0.

8. ROXBURY DAM AND RESERVOIR

The Roxbury project was investigated for flood control only. The dam site considered for this report is located in the town of Roxbury, on the Swift River about 11 miles above its mouth. The dam approximately 2,000 feet long, with a maximum height of 112 feet would impound 36,300 acre-feet of flood control storage to control $8\frac{1}{2}$ inches

of runoff from the tributary drainage area of 80 square miles. The crest of the spillway would be at elevation 810 mean sea level, and the top of the rolled earth dam at an elevation of 830. The reservoir area includes woodland, farmland, and approximately 20 houses. One road, Route 16, would require relocation and raising. The total cost of the project is estimated to be \$5.0 million. The benefit-cost ratio is about 0.7 to 1.0.

9. DIXFIELD DAM AND RESERVOIR

The dam site is in the towns of Mexico and Dixfield, Maine on the Webb River approximately 1.3 miles above its mouth. The project, considered for flood control alone, would require a rolled earth dam approximately 3,080 feet long, 66 feet high with top at elevation 486, above mean sea level; a concrete spillway with crest at elevation 456; and gated outlet works. The reservoir at spillway crest would be about 6 miles long, have a surface area of 2,750 acres, and a gross storage capacity of 55,500 acre-feet, equivalent to 8 inches of runoff from the drainage area of 130 square miles. The reservoir area includes, swampland, woodland, farm land, and 12 buildings including one school house. Route 142 and two secondary roads would require relocation. The inclusion of hydroelectric power to the project would require a dam with top at elevation 530, crest of spillway at elevation 500, and reservoir storage of 55,500 acre-feet for flood control purposes and 151,500 acre-feet for power purposes. A gross head of 64 feet could be developed between a headwater elevation of 484, and a tailwater elevation of 420. Generating facilities for 8,000 kilowatts, in a single unit, would be installed in the powerhouse located at the foot of the dam. The plant would produce about 7.2 million kilowatt-hours annually at a capacity factor of about 10 percent. The total cost of the multiple-purpose project is estimated to be \$11.1 million. The benefit-cost ratio is about 0.5 to 1.0. For flood control alone, the total estimated project cost is \$3.3 million and the benefit-cost ratio is about 0.6 to 1.0.

10. TURNER DAM AND RESERVOIR

This project is also known as Buckfield Dam and Reservoir in the 1938 survey report and the New England-New York Inter-Agency Committee report of 1955. The project was considered for flood control and hydroelectric power for this report. The dam site would be located on the Nezinscot River in the town of Turner, Maine. As a flood control project, the rolled earth dam, approximately 1,280 feet

long including a concrete spillway 547 feet long, would have a maximum height of 58 feet and a top elevation of 360 feet above mean sea level. The spillway with crest at elevation 340 and gated outlet works would be located in the south abutment of the dam. The reservoir at spillway crest would extend up the Nezinscot River about 6.4 miles, up Martin Stream 6.8 miles, and up Bog Brook 3.2 miles; and would have a surface area of 3,360 acres. The reservoir would have a flood control storage capacity of 49,400 acre-feet equivalent to 6 inches of runoff from the tributary drainage area of 155 square miles. The reservoir area consists of swamp, woodland, and farm lands. Routes 4 and 117 and three secondary roads require relocation and raising. Nine buildings, two schools, and one cemetery are within the reservoir area. The modifications required in the project to provide hydroelectric power would include an increase in height of the dam to elevation 370, and crest of spillway to elevation 350. The reservoir would provide for flood control storage of 49,400 acre-feet, equivalent to 6 inches of runoff from the tributary drainage of 155 square miles, and 34,100 acre-feet of storage for power purposes. A gross head of 34 feet could be developed between a headwater elevation of 336 and a tailwater elevation of 302. Generating facilities for 5,000 kilowatts would be installed in the power house located at the downstream toe of the dam. The plant would produce about 4.7 million kilowatt-hours annually at a capacity factor of about 10 percent. The total cost of the multiple-purpose project is estimated to be \$7.3 million, and the benefit-cost ratio is 0.5 to 1. For flood control alone, the total estimated project cost is \$3.56 million and the benefit-cost ratio is 0.4 to 1.

PART II - LOCAL PROTECTION PROJECTS

11. INTRODUCTION

The following paragraphs present brief descriptions of local protection sites investigated but not recommended at this time since studies indicate that flood damages preventable by the construction of the projects are insufficient to justify the projects. Protection at Gorham, New Hampshire and Norway and Mexico, Maine was also previously investigated under Section 205 of Public Law 87-874 and found not economically feasible. Pertinent data regarding local protection projects studied but not recommended is summarized in Table I-2 at the end of this appendix.

12. BERLIN, NEW HAMPSHIRE

The Dead River, a small tributary flowing through the city of Berlin, has caused considerable damage in past floods. Losses of \$50,000 were sustained by business properties in the flood of March 1936. Since the river is confined to a conduit constructed under buildings in the city, protection by means of dams and reservoirs above the community on the Dead River and Jericho Brook was considered to be the most feasible solution to the flood problem. However, the cost of such work is not justified at this time.

13. GORHAM, NEW HAMPSHIRE

This community, vulnerable to floods from the Androscoggin, Moose and Peabody Rivers, suffered losses of \$39,000 in the flood of March 1936. Gorham is located along the right bank of the Androscoggin River and is bordered by Moose Brook and the Moose River on the upstream end and the Peabody River on the downstream end of the community. Two flood-prone areas were studied for protection; one located between Moose Brook and the Moose River and the other between the Moose and Peabody Rivers. The former area could be protected by the construction of 2,600 feet of earth dike and pumping facilities, and the latter area by 9,500 feet of earth dike, a pressure conduit, and pumping facilities. A plan to divert Moose Brook and Moose River to the Androscoggin River upstream from Gorham was found to be more costly than protection by earth dikes. At this time, local protection works are not economically feasible at these locations.

14. RUMFORD, MAINE

The community of Rumford suffered flood losses of \$894,000 in March 1936. The area investigated for local protection works is located between the Oxford Paper Company plant and Androscoggin River and would consist of pumping facilities, and 1,450 lineal feet of concrete flood wall constructed at the downstream end of an existing earth dike. At the present time, Federal participation in this work is not warranted. An alternative method of providing local protection work was to divert the floodwaters from above the community into a new channel and/or tunnel to the Androscoggin River below Rumford. This method of providing flood protection was also found to be not economically justified at this time. Consideration was given to removing Wheeler Island, just upstream of Logan Brook, which is reported to be the cause of ice jams backing up all the way to Rumford Center. This was likewise found to be economically infeasible.

15. MEXICO, MAINE

The community of Mexico is located on the left bank of the Swift and Androscoggin Rivers. The flood losses in the community amounted to \$442,000 in March 1936, with the losses sustained mostly by residential and commercial properties. Local protection could be provided by the construction of 2,400 feet of earth dike, 350 feet of concrete flood wall, and pumping facilities, but the cost of such work is not economically justified at this time.

16. WAYNE, MAINE

Nearly every spring, the high water on the Androscoggin River backs up the Dead River into Androscoggin Lake, raising the level of the lake 12 to 15 feet. During the record flood of March 1936, the surface rose about 25 feet, flooding residential and commercial properties in Leeds Center and Wayne, and many summer homes on the shore of the lake. The flood damages amounted to approximately \$40,000. A dam with flap gates was constructed near the mouth of the Dead River in 1933 to prevent high water on the Androscoggin River from flowing into Androscoggin Lake, but the dam was of insufficient height, and high flows (10 feet or more above low water) overtopped the structure. Protection against flooding of properties in this region could be provided by constructing a new and higher dam on the Dead River, but costs of such works are not economically justified at this time. Since

the storage of flood waters afforded by the lake has a marked influence on downstream flood heights, an equal amount of storage at some other location is required if a new structure for flood control is constructed.

17. LEWISTON, MAINE

Damage by floods in Lewiston amounted to \$367, 500 in March 1936. Local protection was investigated and studied for three flood-prone areas, one immediately upstream of the Maine Central Bridge, the second from the Union Water Power Company Dam to the Grand Trunk Railroad Bridge, and the third from and including the canal at the end of Chestnut Street to about 500 feet downstream of Gully Brook. Protection against flooding could be provided by the construction of 1, 830 feet of earth dike and 150 feet of concrete floodwall in the upper area, 1, 170 feet of concrete floodwall and 1, 240 feet of earth dike for the middle area, and 2, 850 feet of concrete floodwall and 1, 310 feet of earth dike for the lower area. Pumping and drainage facilities would be required for each area. Studies on these areas indicated that the construction of local protection works for a single area or any combination thereof is not economically feasible at this time.

18. AUBURN, MAINE

The flood damage in this city amounted to \$540, 500 in March 1936. The major portion of the damage was sustained by industrial and commercial establishments located along the Androscoggin River. Protection against flooding was studied for two flood-prone areas. Flood protection for one area, extending downstream from the Maine Central Railroad Bridge to about 1, 100 feet below North Bridge near the river end of Drummond Street, could be provided by the construction of 1, 930 feet of concrete floodwall, 380 feet of earth dike, a pressure conduit, two pumping stations, and appurtenant drainage facilities. Flood protection for the second area, just downstream from the Little Androscoggin River, could be provided by construction of 1, 600 feet of concrete floodwall, 490 feet of earth dike, a pumping station, and appurtenant drainage facilities. However, the costs of such works were found to exceed the benefits.

19. LISBON FALLS, MAINE

The mill buildings of the Worumbo Division of J. P. Stevens and Company, Incorporated, and the U. S. Gypsum Company in the

community of Lisbon Falls have been badly damaged by past floods on the Androscoggin River. Losses of \$800,000 were experienced in the flood of March 1936. Flood protection could be provided by the construction of floodwalls, pumping stations, dikes, canal control structures, and removal of an existing dam, but such works are not justified at this time.

20. TOPSHAM, MAINE

Consideration was given to the possibility of providing local protection works along the low left bank of the Androscoggin River above the lower highway bridge in the community of Topsham. The flood-prone area is occupied by the mill buildings of the Pejepscot Paper Division of the Hearst Publishing Company, Incorporated. The losses experienced in the flood of March 1936 amounted to \$291,000. Protection could be provided by floodwalls, dikes, canal control structure, and pumping facilities. This work is not economically feasible at this time.

21. BRUNSWICK, MAINE

The community of Brunswick is located at the head of tidewater in the Androscoggin River. During the flood of March 1936 the community sustained losses of \$435,000. The magnitude of these losses was principally due to high water elevations caused by ice jams which formed at ledge outcrop constrictions in the river channel. Although a reduction in flood damage is not economically feasible at this time, these losses could be reduced by the removal of ledge outcrops in and immediately below the community in the area known as the "Narrows".

TABLE I-1
RESERVOIRS STUDIED BUT NOT RECOMMENDED
PERTINENT DAM AND RESERVOIR DATA

Reservoir	Purpose	Drainage Area (sq. mi.)	Storage-acre-feet		Gross Head (Ft.)	Installed Capacity (kw)	Avg. Annual Generation (million kwh)	Project Cost (\$1,000)	Annual		B/C Ratio
			Flood Control	Power & Recreation					Costs (\$1,000)	Benefits (\$1,000)	
Dead R., N.H.	F.C.	15	6,400	-	-	-	-	3,500	132	26	0.2
Moose R.	F.C.	20	8,500	-	-	-	-	1,800	73	40	0.6
Moose R.	F.C. & Power	20	8,500	2,900	72	1,500	1.3	3,600	150	106	0.7
Peabody R.	F.C.	43	18,500	-	-	-	-	4,700	173	81	0.5
Peabody R.	F.C. & Power	43	18,500	16,500	138	6,000	5.4	12,200	458	280	0.6
Wild R.	F.C.	49	15,700	-	-	-	-	3,200	128	77	0.6
Wild R.	F.C. & Power	49	15,700	13,400	113	6,000	5.0	8,200	318	274	0.9
Ellis R.	F.C.	164	70,000	-	-	-	-	6,300	245	203	0.8
Ellis R.	F.C. & Rec.	164	70,000	40,000	-	-	-	7,300	280	222	0.8
Ellis R.	F.C. & Power & Rec.	164	70,000	43,000	28	5,000	4.0	10,300	400	330	0.8
Hale, Swift R.	F.C.	111	47,400	-	-	-	-	8,700	313	183	0.6
Hale, Swift R.	F.C. & Power & Rec.	111	47,400	284,600	250	33,750	31.0	31,100	1,193	912	0.8
Rumford	F.C.	988	237,000	-	-	-	-	20,700	780	520	0.7
Rumford	F.C. & Power	988	316,000	344,000	46	56,250	74.0	57,500	2,280	1,856	0.8
Roxbury, Swift R.	F.C.	80	36,300	-	-	-	-	5,000	187	133	0.7
Dixfield, Webb R.	F.C.	130	55,500	-	-	-	-	3,300	130	77	0.6
Dixfield, Webb R.	F.C. & Power	130	55,500	151,500	64	8,000	7.2	11,100	430	229	0.5
Turner, Nezinscot	F.C.	155	49,400	-	-	-	-	3,560	142	57	0.4
Turner, Nezinscot	F.C. & Power	155	49,400	34,100	34	5,000	4.7	7,300	285	153	0.5

TABLE I-2

LOCAL PROTECTION PROJECTS STUDIED BUT NOT RECOMMENDED

PERTINENT DATA
(1964 Price Level)

<u>Town or City</u>	<u>State</u>	<u>River</u>	<u>Approx. Total First Costs</u>	<u>Approx. Annual Charges</u>	<u>Approx. Annual Benefits</u>	<u>Approx. Benefit- Cost Ratio</u>
Berlin	New Hampshire	Dead	\$ 1,000,000	-	\$ 100,000 *	-
Gorham, Dikes	New Hampshire	Androscoggin	1,100,000	44,000	3,000	0.1
Gorham, Diversion	New Hampshire	Androscoggin	1,500,000	60,000	-	-
Rumford, Dikes	Maine	Androscoggin	500,000	-	334,000 *	-
Rumford, Tunnel Diversion	Maine	Androscoggin	11,000,000	-	1,900,000 *	-
Mexico	Maine	Swift and Androscoggin	690,000	27,000	13,500	0.5
Wayne	Maine	Dead	300,000	-	276,000 *	-
Lewiston	Maine	Androscoggin	2,100,000	84,000	24,000	0.3
Auburn, above Little Androscoggin	Maine	Androscoggin	1,100,000	44,000	8,000	0.2
Auburn, below Little Androscoggin	Maine	Androscoggin	800,000	32,000	3,000	0.1
Lisbon Falls	Maine	Androscoggin	1,100,000	40,000	16,000	0.4
Topsham	Maine	Androscoggin	1,800,000	70,000	50,000	0.7
Brunswick	Maine	Androscoggin	1,700,000	-	700,000 *	-

* Total damages from a recurrence of 1936 flood.